US012246226B2

(12) **United States Patent**
Mizutani et al.

(10) **Patent No.: US 12,246,226 B2**
(45) **Date of Patent: Mar. 11, 2025**

(54) **GOLF CLUB HEAD**

(71) Applicant: **SUMITOMO RUBBER INDUSTRIES, LTD.**, Kobe (JP)

(72) Inventors: **Naruhiro Mizutani**, Kobe (JP); **Daisuke Kohno**, Kobe (JP); **Hirotaka Nakamura**, Kobe (JP); **Jun Kodaka**, Kobe (JP)

(73) Assignee: **SUMITOMO RUBBER INDUSTRIES, LTD.**, Kobe (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 215 days.

(21) Appl. No.: **17/902,437**

(22) Filed: **Sep. 2, 2022**

(65) **Prior Publication Data**

US 2023/0080945 A1 Mar. 16, 2023

(30) **Foreign Application Priority Data**

Sep. 3, 2021 (JP) 2021-144283

(51) **Int. Cl.**
A63B 53/04 (2015.01)

(52) **U.S. Cl.**
CPC ***A63B 53/0412*** (2020.08); ***A63B 53/0437*** (2020.08); ***A63B 53/0466*** (2013.01); *A63B 2209/023* (2013.01)

(58) **Field of Classification Search**
CPC A63B 53/0412; A63B 2209/023; A63B 53/0437; A63B 53/0466
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,587,758 A * 6/1926 Charavay A63B 53/04 473/327
3,595,577 A * 7/1971 Hodge A63B 53/04 473/314

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2020-171434 A 10/2020
WO WO-2011094188 A1 * 8/2011 .... A63B 53/0466

OTHER PUBLICATIONS

@nd Swing, Taylormade R510 Driver, https://www.2ndswing.com/golf-clubs/drivers/taylormade-r510-driver/right-handed-stiff-graphite-44dot25in-d-d2335072641, 2002.*

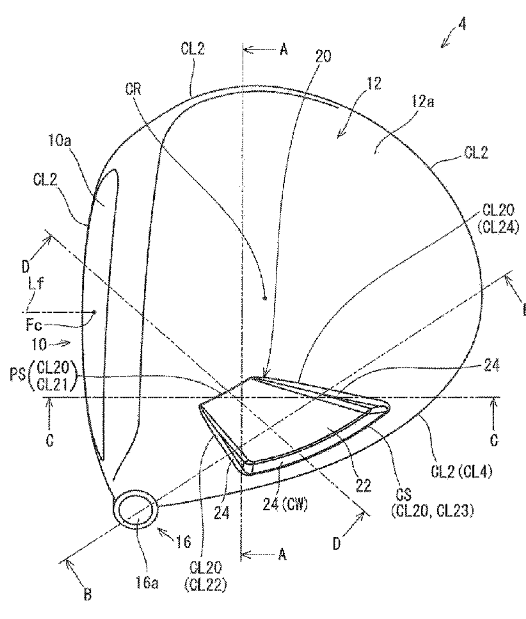
(Continued)

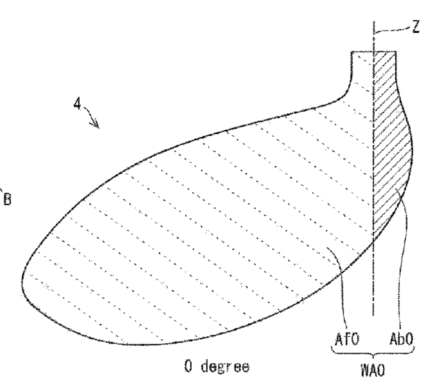
Primary Examiner — William M Pierce
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A state of a head placed such that its shaft axis is vertical to a horizontal plane and a face normal line is parallel to a perpendicular plane on which the shaft axis lies is defined as a 0-degree state. A direction parallel to the perpendicular plane and parallel to the horizontal plane is defined as a projection direction. A projected area of the head projected in the projection direction when the head is rotated by θ° about the shaft axis toward a back side from the 0-degree state is denoted by WAθ. WAθ is divided by the shaft axis into an area Afθ and an area Abθ. Airflow causes a force acting on the area Afθ in a face-closing direction and a force acting on the area Abθ in a face-opening direction. (Af**90**−Ab**90**) is −4500 (mm^2) or less. (Af**15**−Ab**15**) is 4700 (mm^2) or less.

12 Claims, 37 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

5,318,297	A *	6/1994	Davis	A63B 60/00 473/327
5,505,448	A *	4/1996	Park	A63B 60/006 473/327
5,997,413	A *	12/1999	Wood, IV	A63B 53/0466 473/328
D489,424	S *	5/2004	Lee	D21/733
7,713,138	B2 *	5/2010	Sato	A63B 53/0466 473/328
8,366,565	B2 *	2/2013	Tavares	A63B 60/00 473/328
8,702,531	B2 *	4/2014	Boyd	A63B 53/02 473/328
9,861,864	B2 *	1/2018	Beach	A63B 53/0466
10,130,855	B2 *	11/2018	Stokke	A63B 53/08
11,465,019	B2 *	10/2022	Albertsen	A63B 53/0466
2011/0136584	A1 *	6/2011	Boyd	A63B 60/52 473/345
2011/0165961	A1 *	7/2011	Cackett	A63B 60/00 473/282
2011/0192001	A1 *	8/2011	Evans	A63B 53/0466 29/407.01
2011/0192002	A1 *	8/2011	Evans	A63B 53/0466 29/407.1
2011/0195801	A1 *	8/2011	Evans	A63B 53/0466 473/345
2011/0247190	A1 *	10/2011	Evans	A63B 53/0466 29/407.01
2011/0250986	A1 *	10/2011	Schweigert	A63B 60/02 473/409
2011/0281663	A1 *	11/2011	Stites	A63B 53/0466 473/327
2011/0281664	A1 *	11/2011	Boyd	A63B 53/0466 473/282
2013/0324296	A1 *	12/2013	Ban	A63B 53/0466 473/345
2016/0339306	A1 *	11/2016	Simone	A63B 60/00
2019/0374824	A1 *	12/2019	Albertsen	A63B 53/0466
2020/0324173	A1	10/2020	Aramaki	
2021/0162280	A1 *	6/2021	Morales	A63B 53/0466
2022/0226699	A1 *	7/2022	Mizutani	A63B 53/0466
2022/0249923	A1 *	8/2022	Kodaka	A63B 53/0408

OTHER PUBLICATIONS

A Review of Dynamic Models and Measurements i Golf, by John McPhee, https://uwaterloo.ca/motion-research-group/sites/ca.motion-research-group/files/uploads/files/review_golf.pdf, 2022.*

* cited by examiner

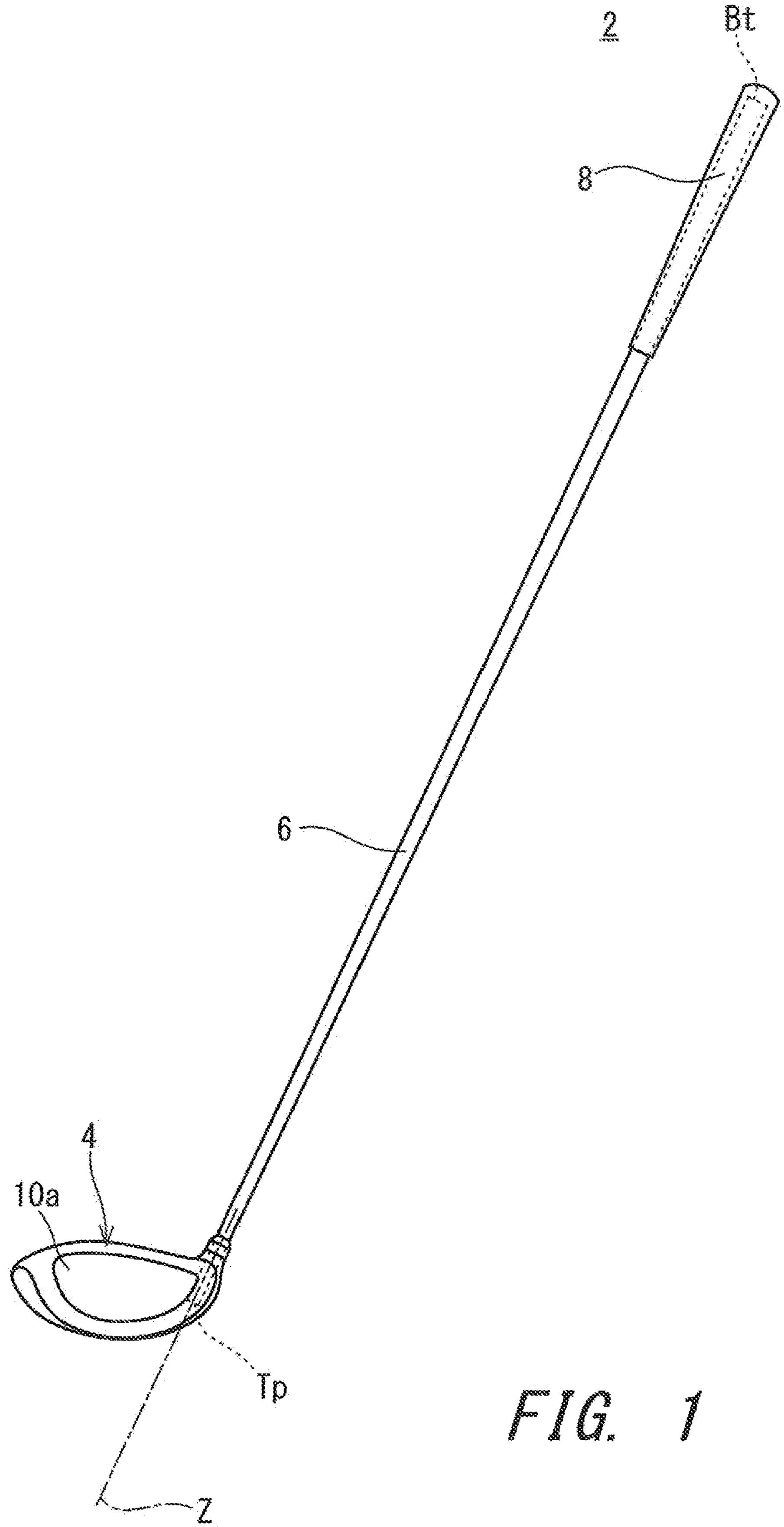


FIG. 1

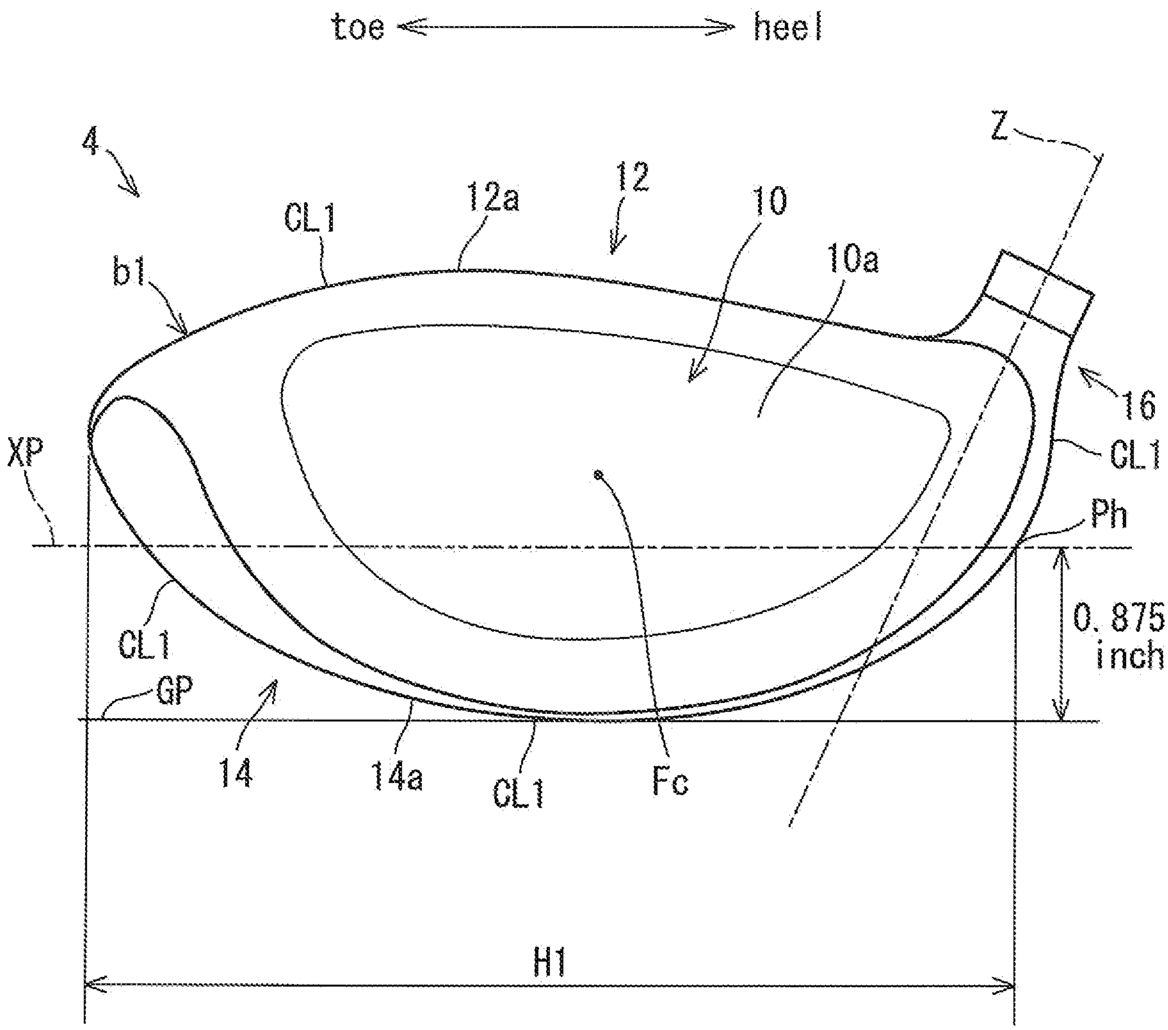

toe
heel
4
12a
12
10
10a
Z
CL1
b1
16
CL1
XP
Ph
0.875
inch
CL1
GP
14
14a
CL1
Fc
H1

FIG. 2

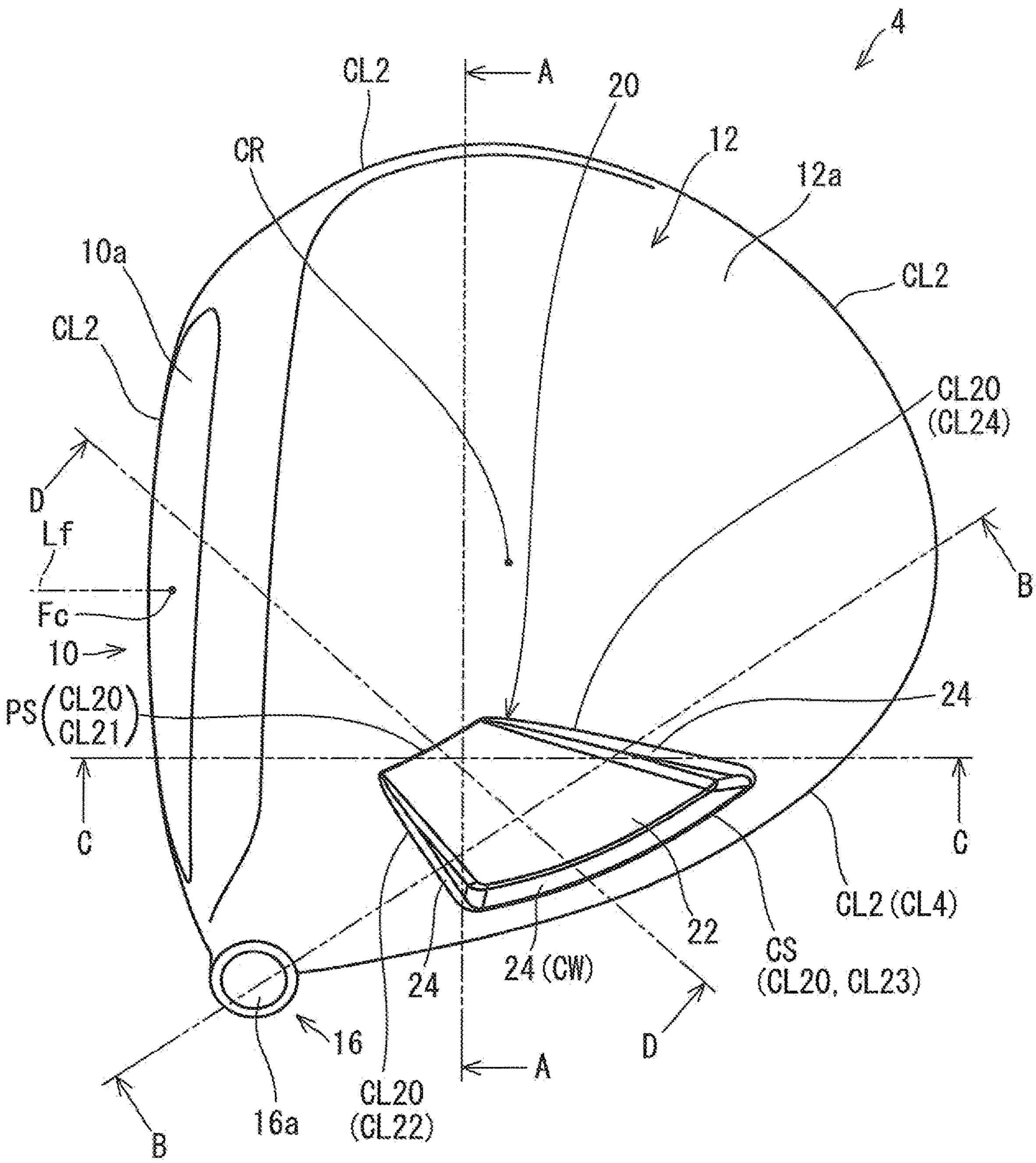

4
CL2
A
20
12
CR
12a
10a
CL2
CL2
CL20
(CL24)
D
Lf
B
Fc
10
PS (CL20 CL21)
24
C
C
CL2 (CL4)
22
24 (CW)
24
CS
(CL20, CL23)
16
D
A
16a
CL20
(CL22)
B

FIG. 3

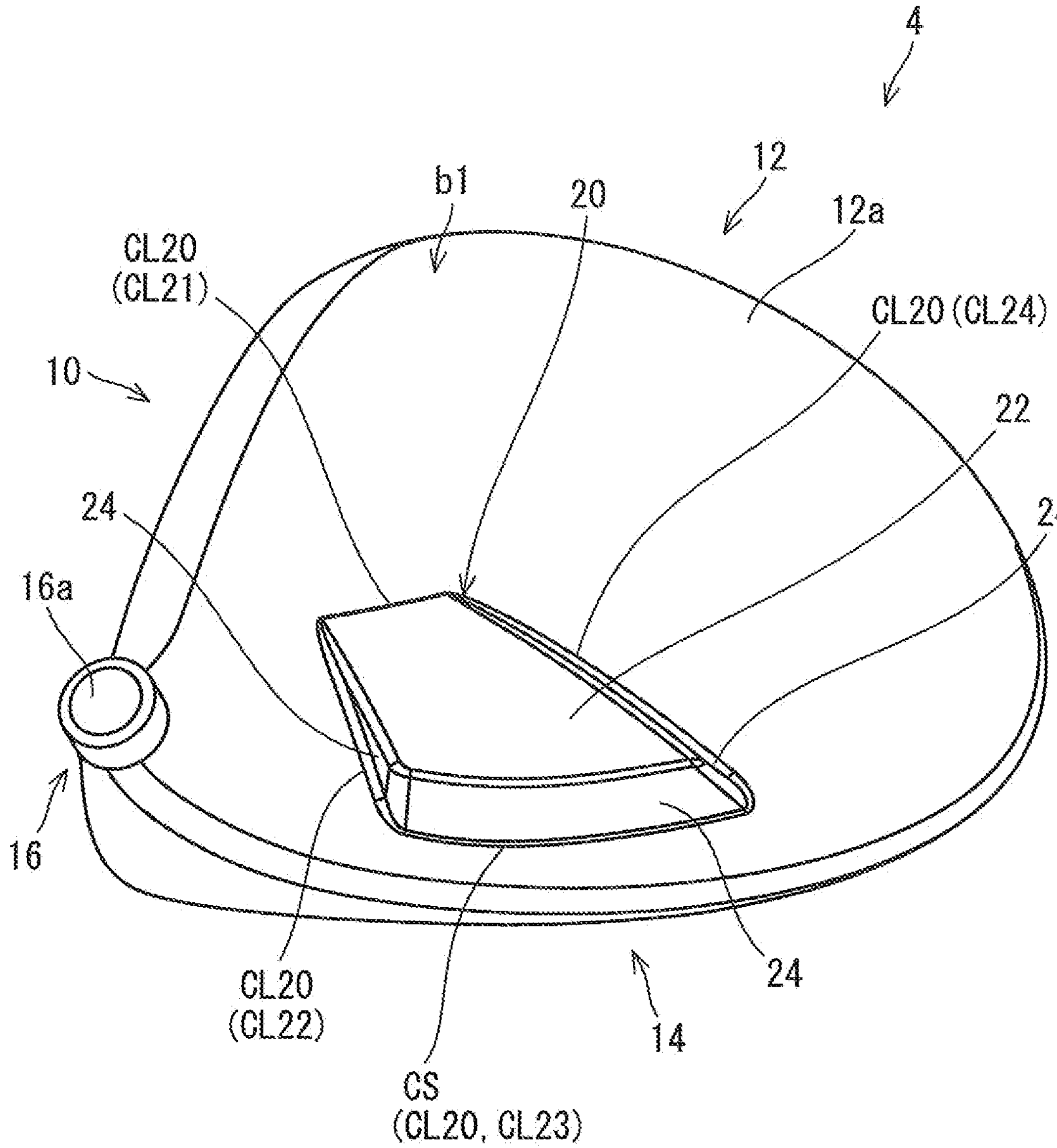

4
12
b1
20
12a
CL20
(CL21)
CL20 (CL24)
10
22
24
24
16a
16
CL20
(CL22)
24
14
CS
(CL20, CL23)

FIG. 4

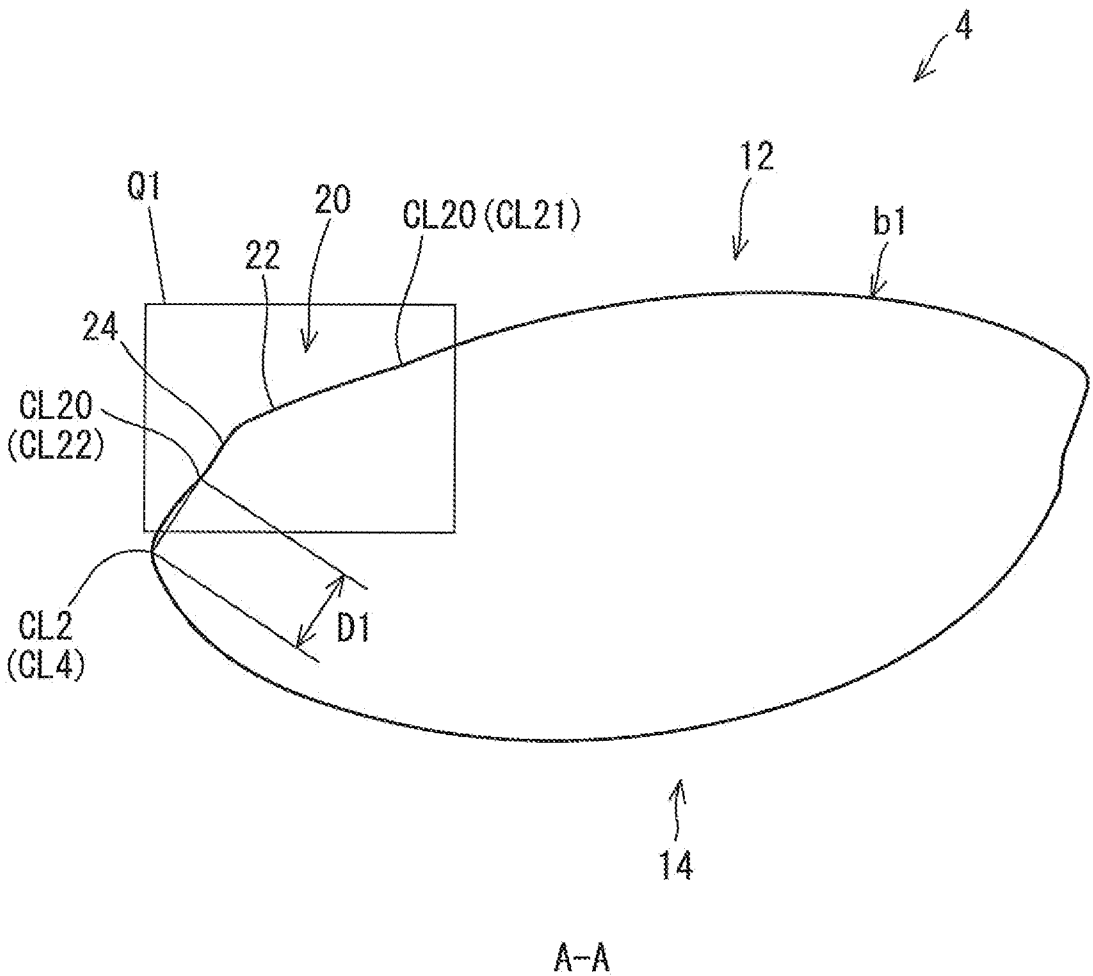


FIG. 5

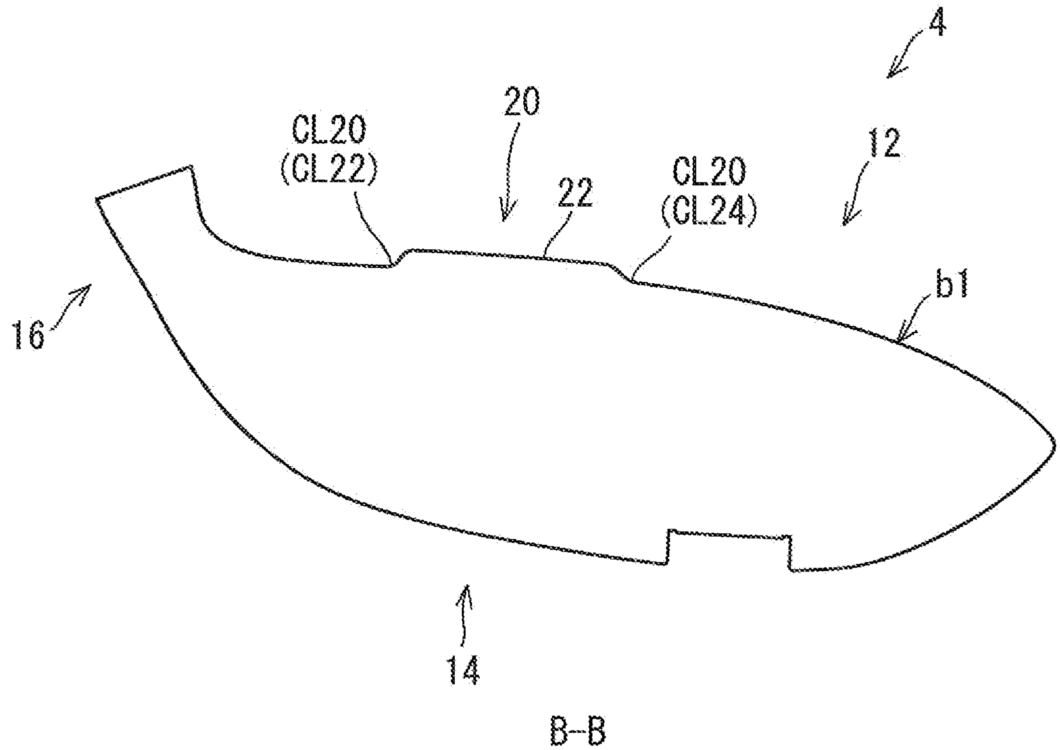


FIG. 6

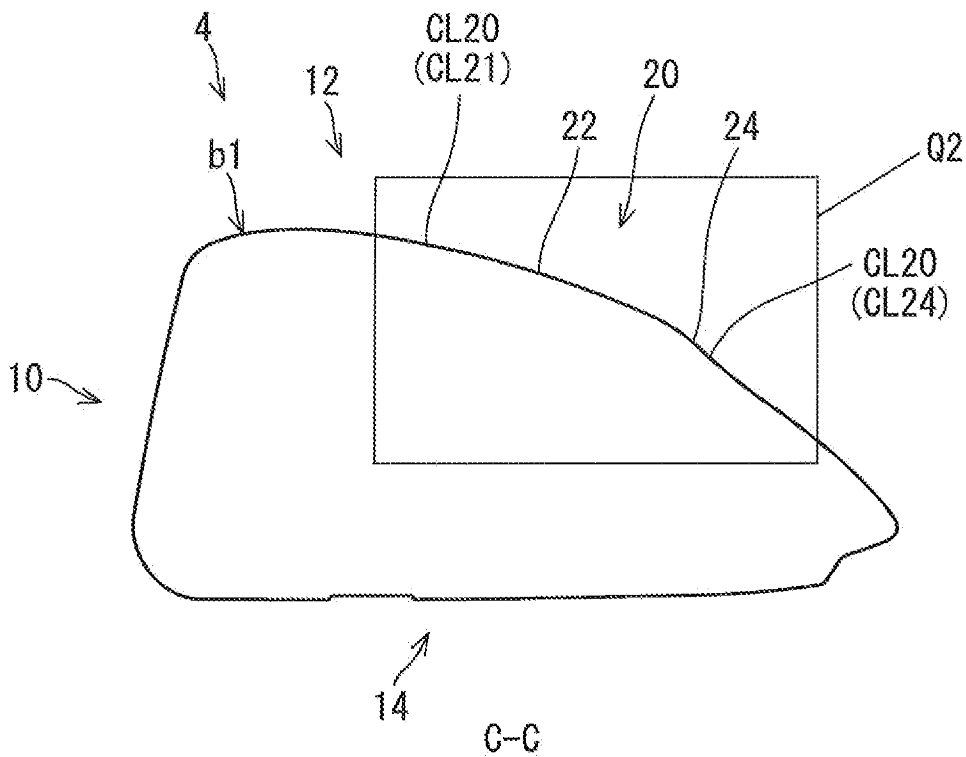


FIG. 7

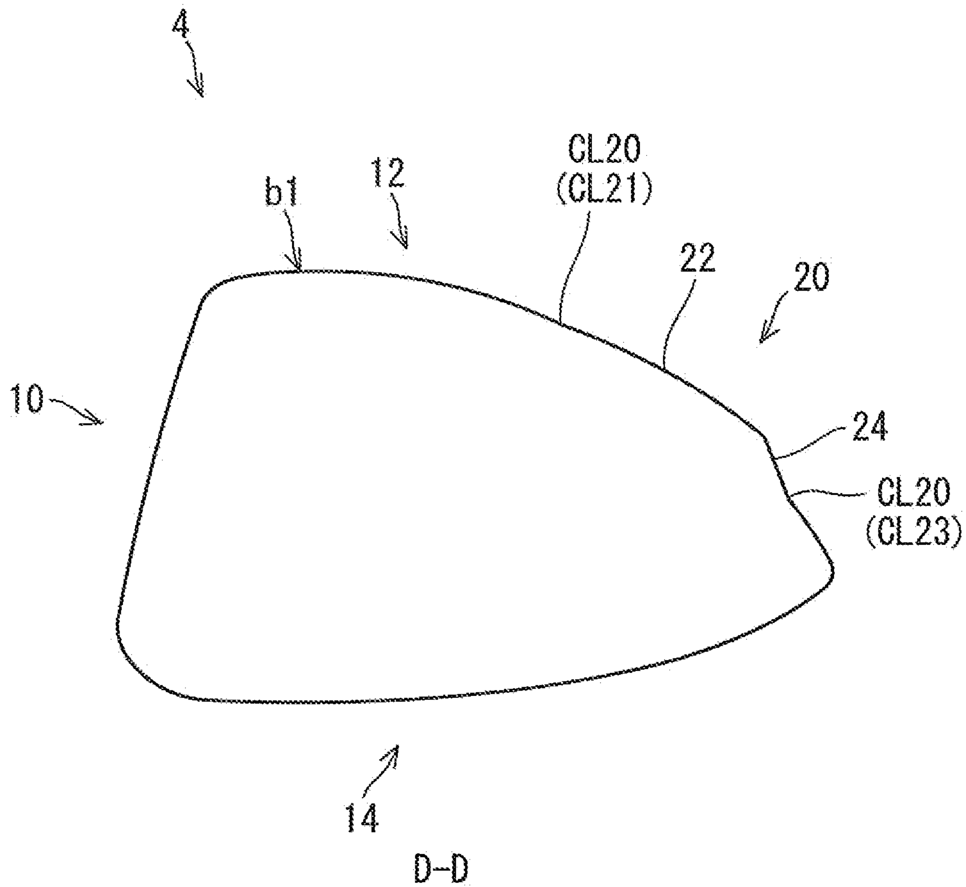
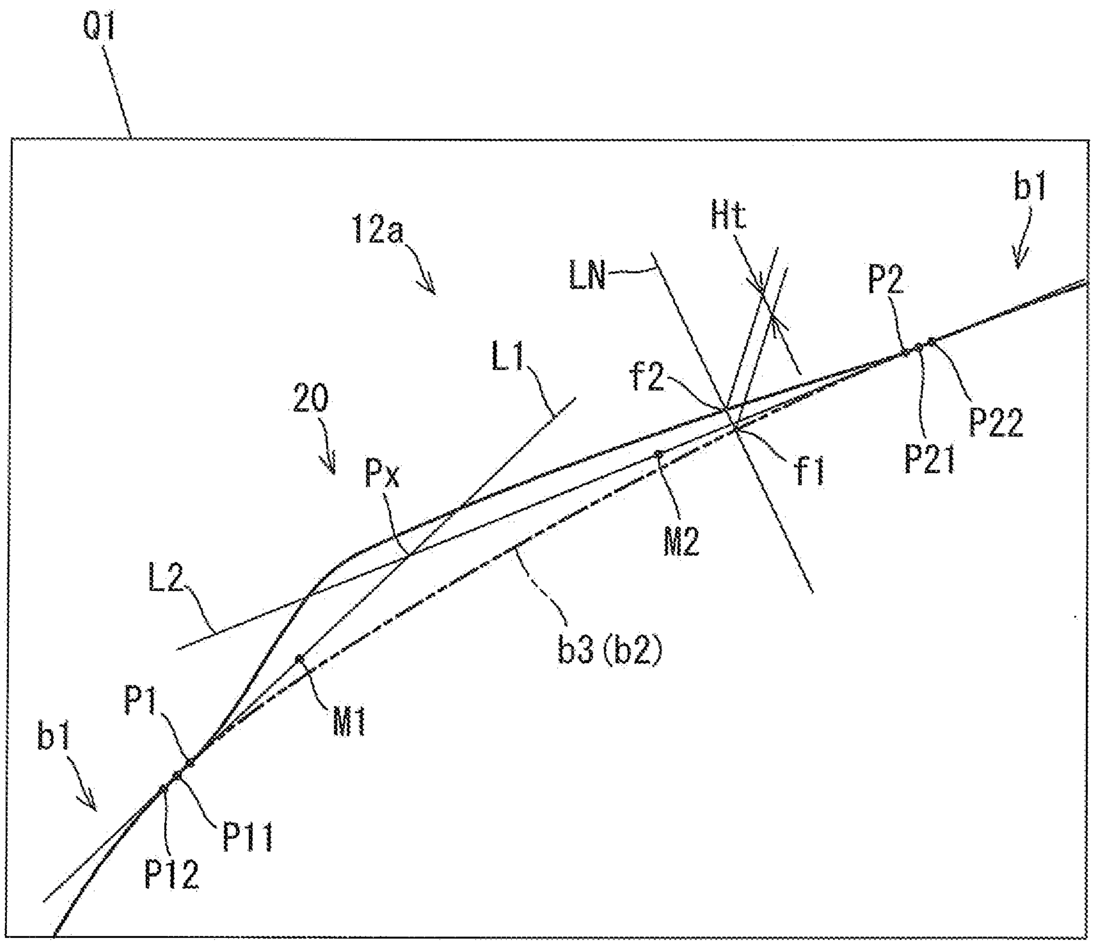


FIG. 8



A-A

FIG. 9

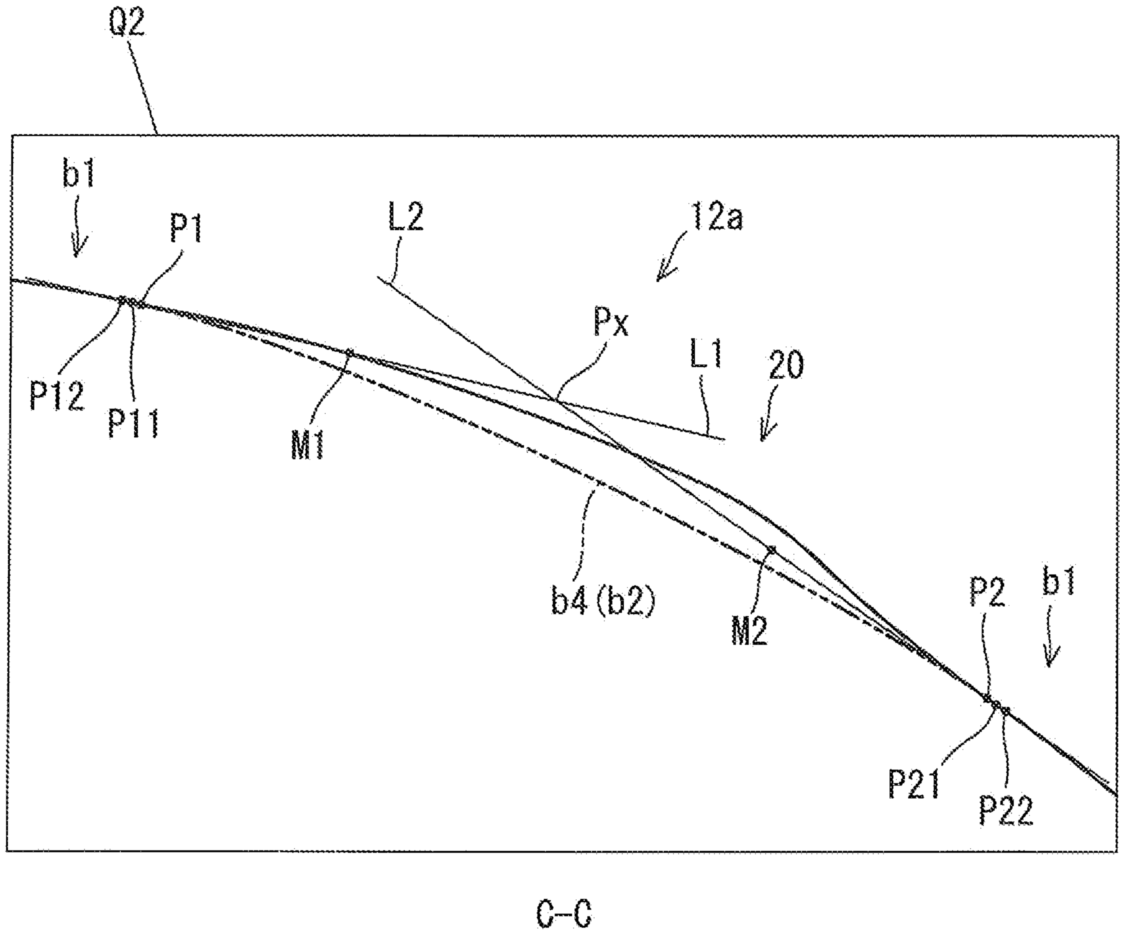


FIG. 10

FIG. 11A

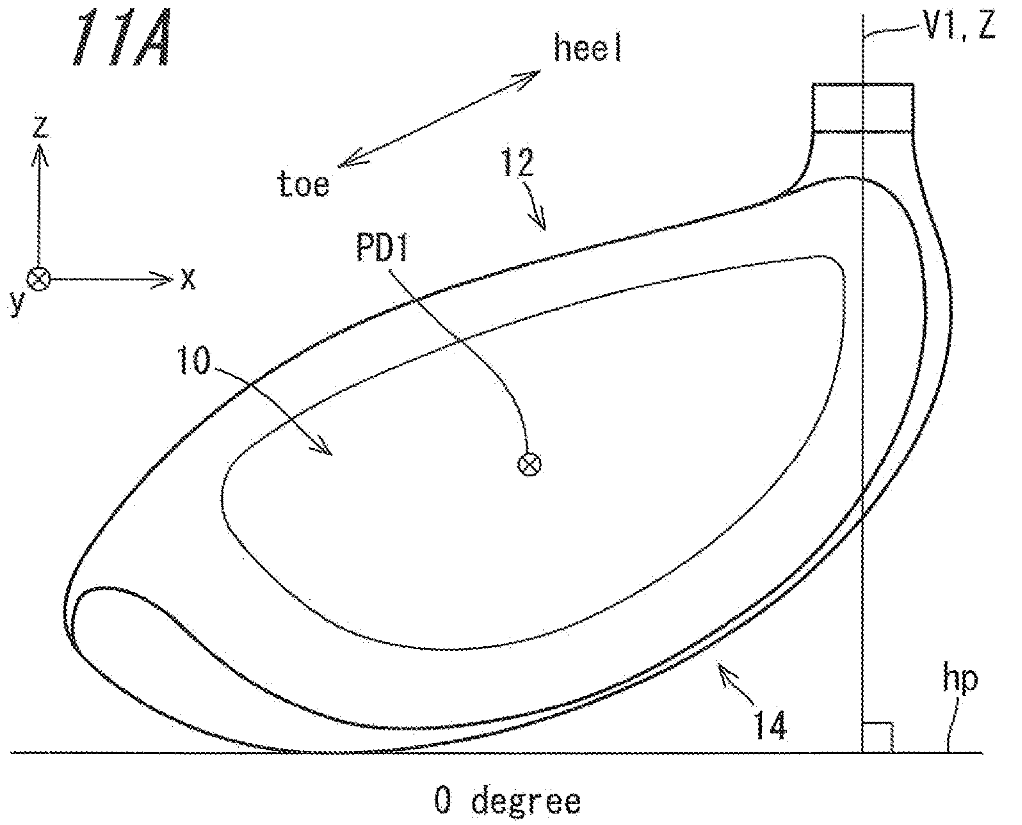
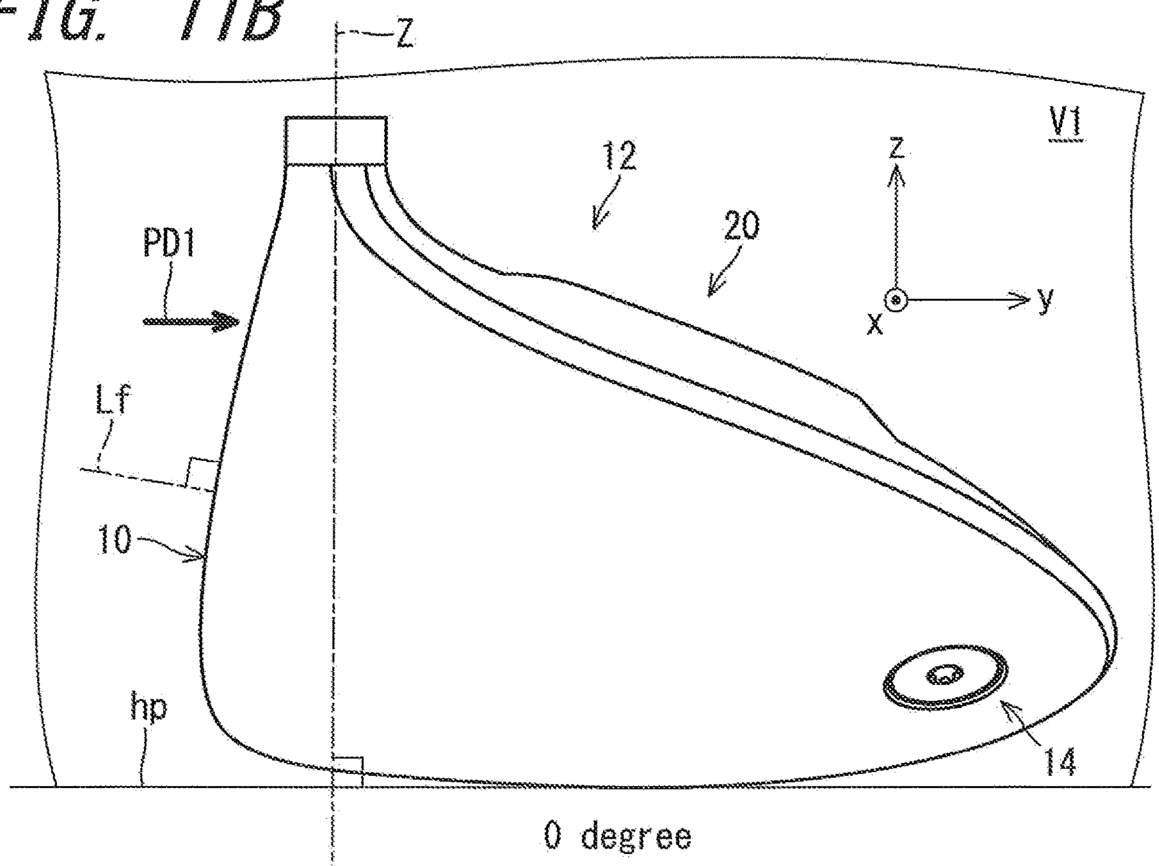


FIG. 11B



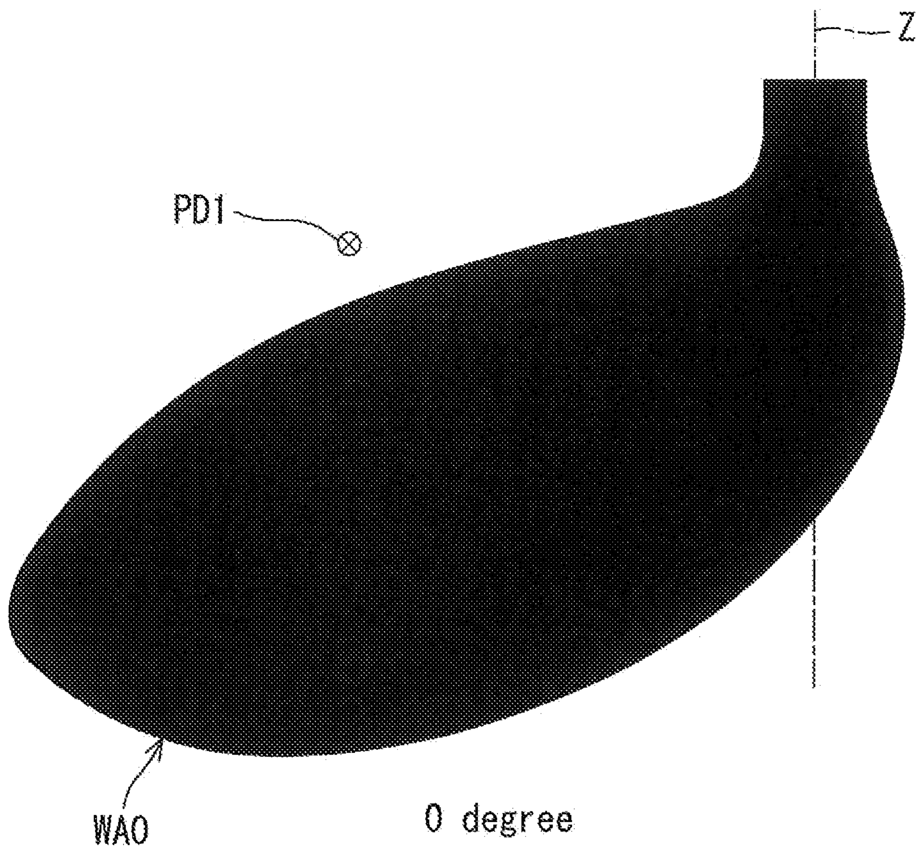
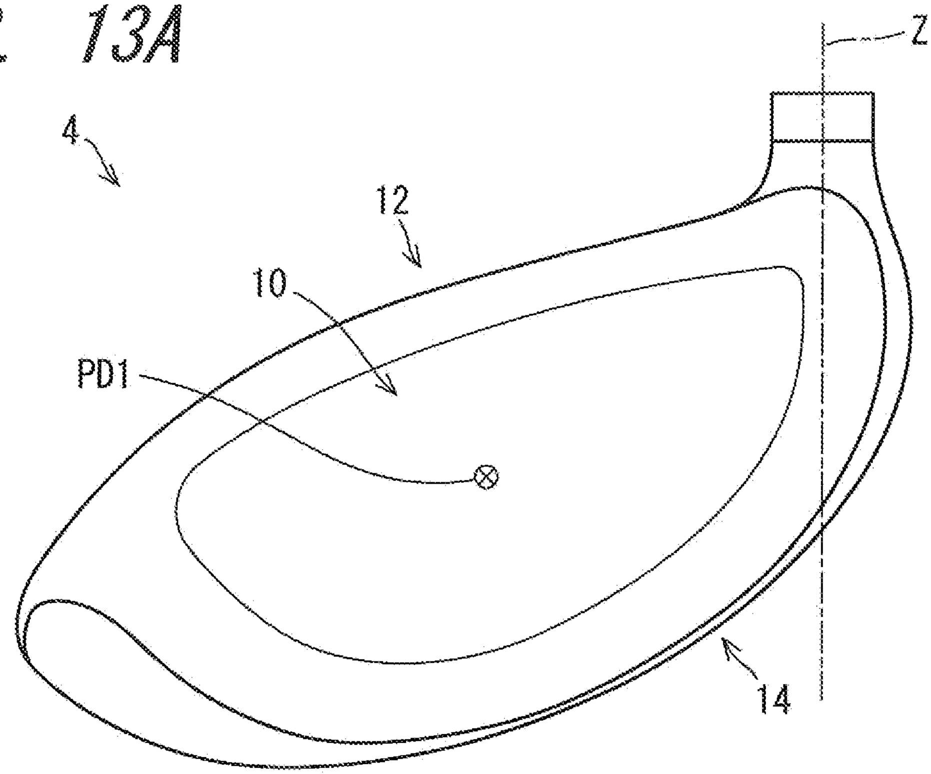


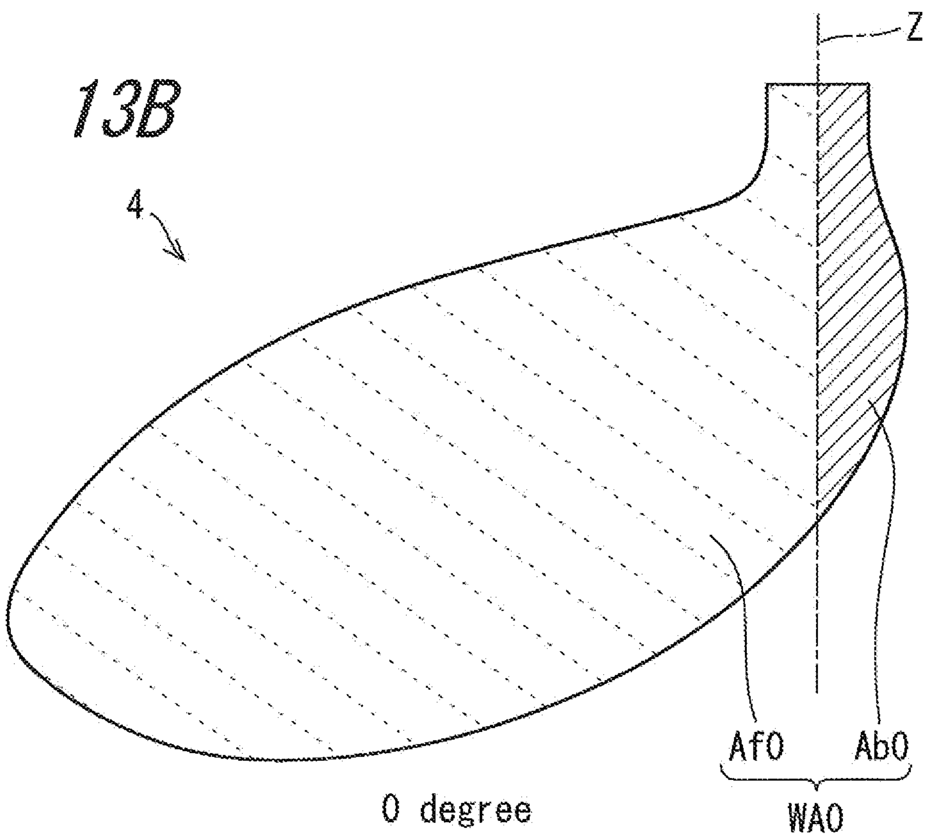
FIG. 12

FIG. 13A



0 degree

FIG. 13B



0 degree

FIG. 14A

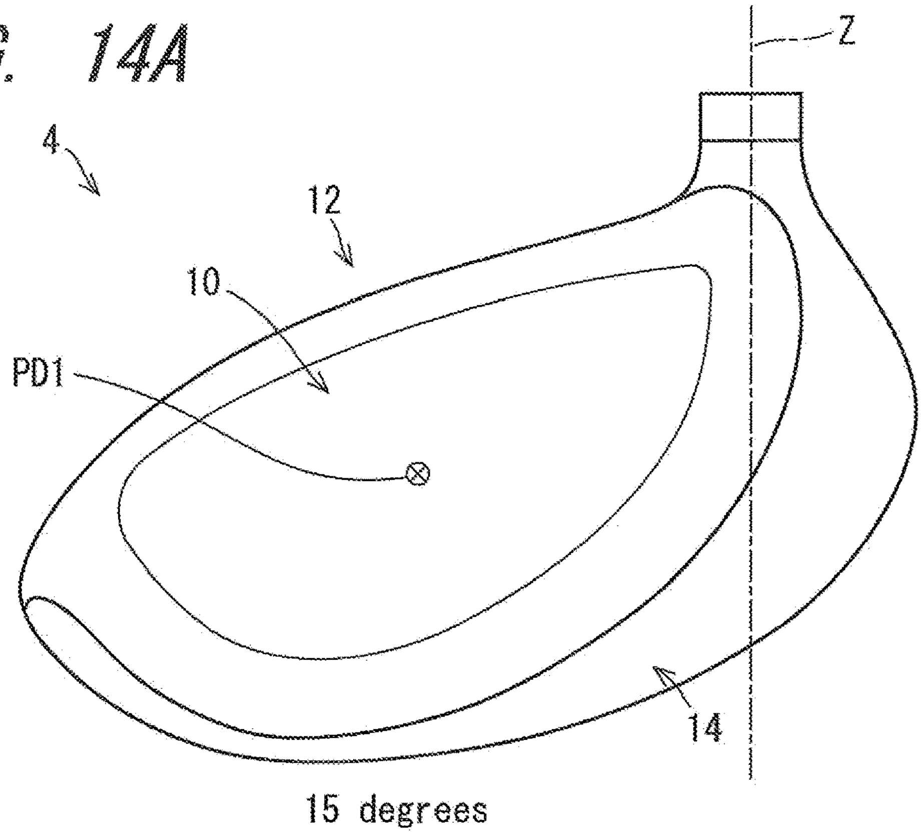


FIG. 14B

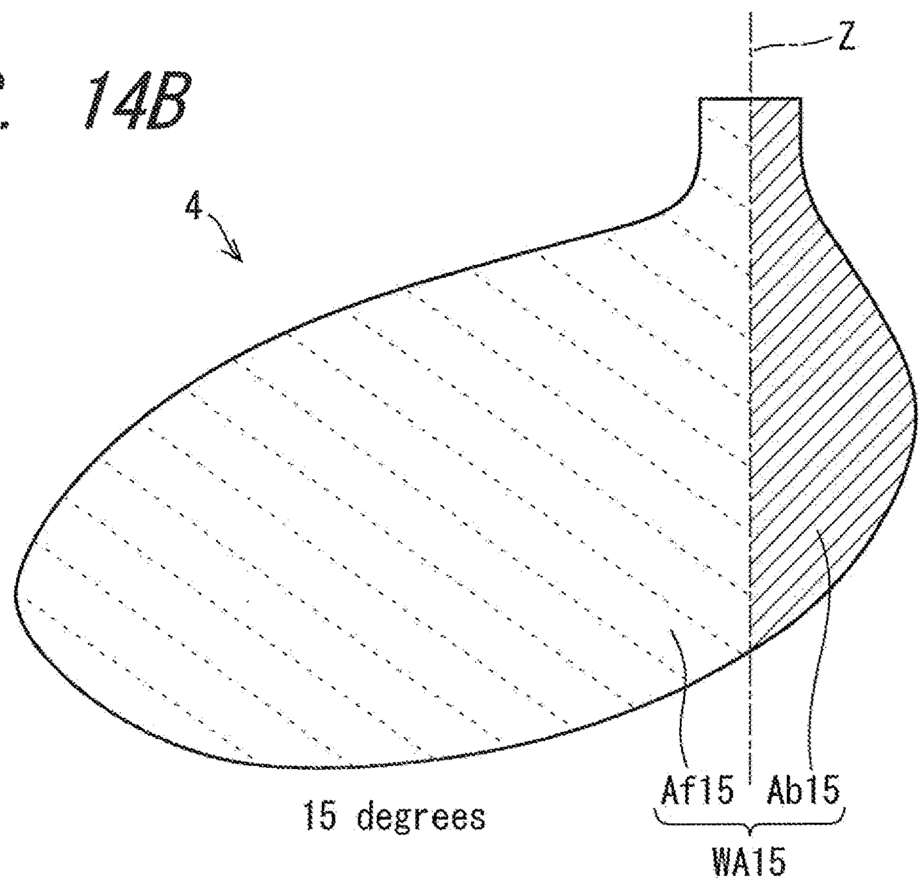


FIG. 15A

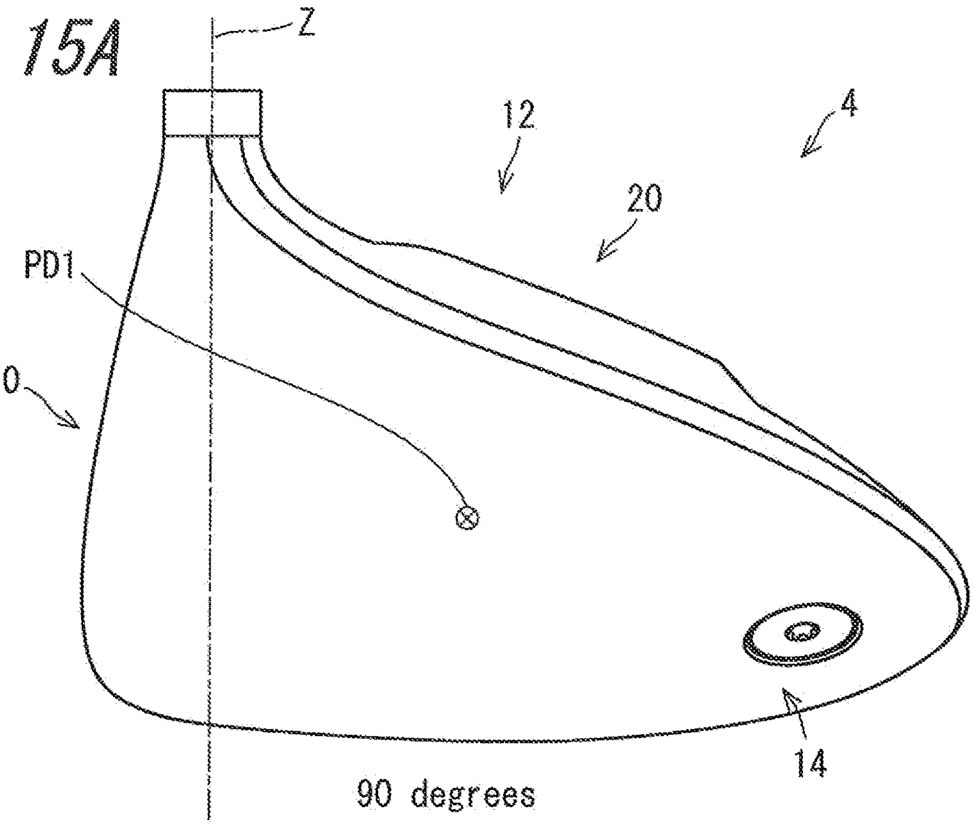
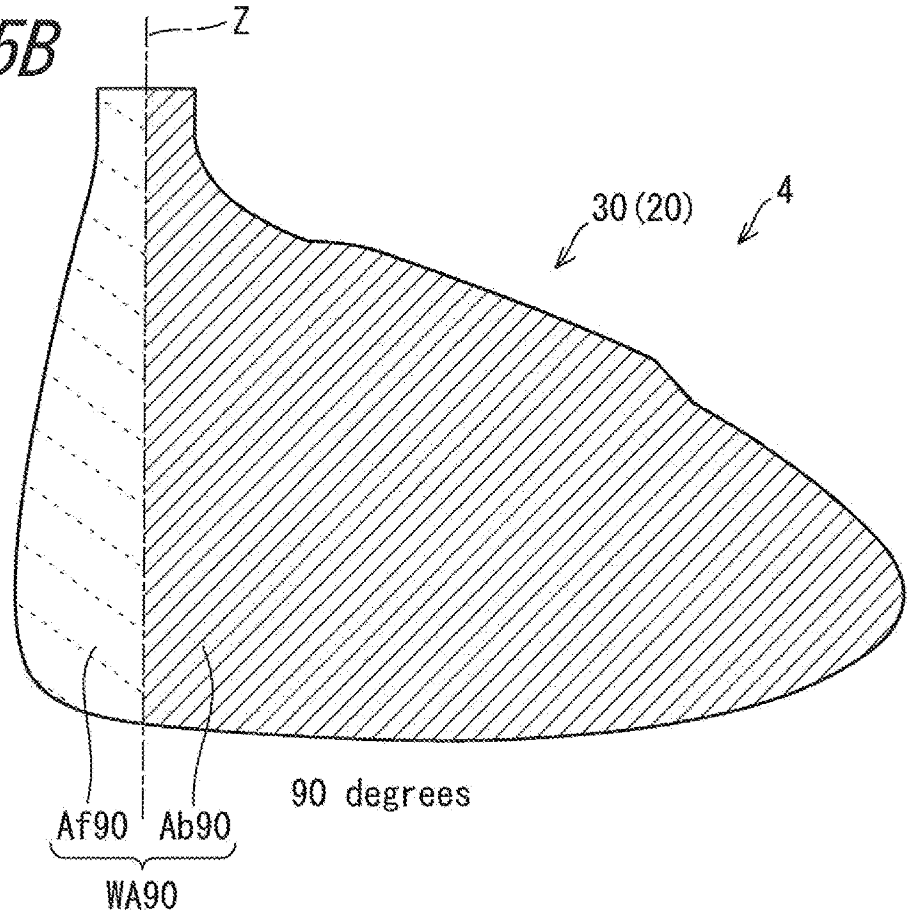


FIG. 15B



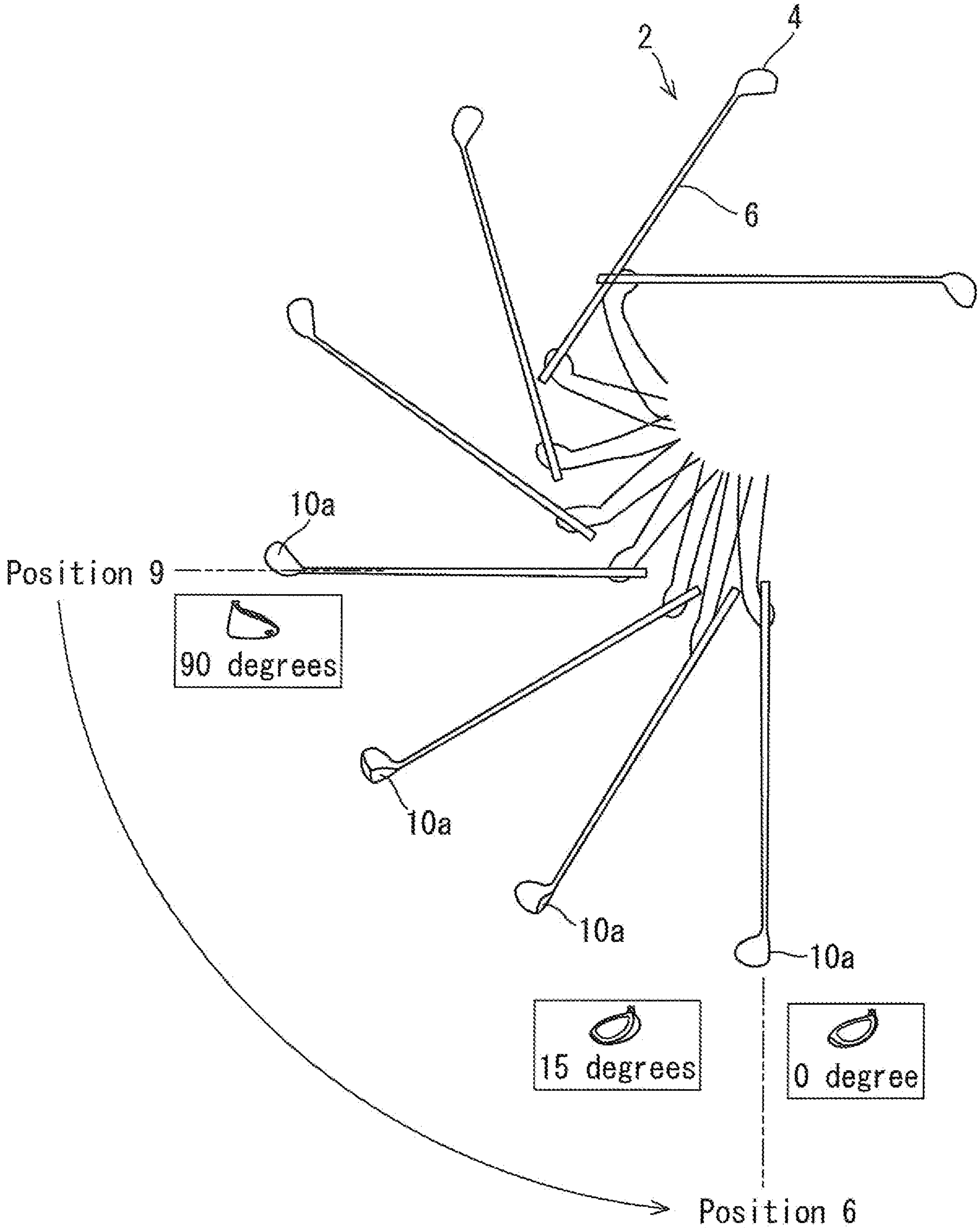

2
4
6
10a
Position 9
90 degrees
10a
10a
10a
15 degrees
0 degree
Position 6

FIG. 16

FIG. 17A

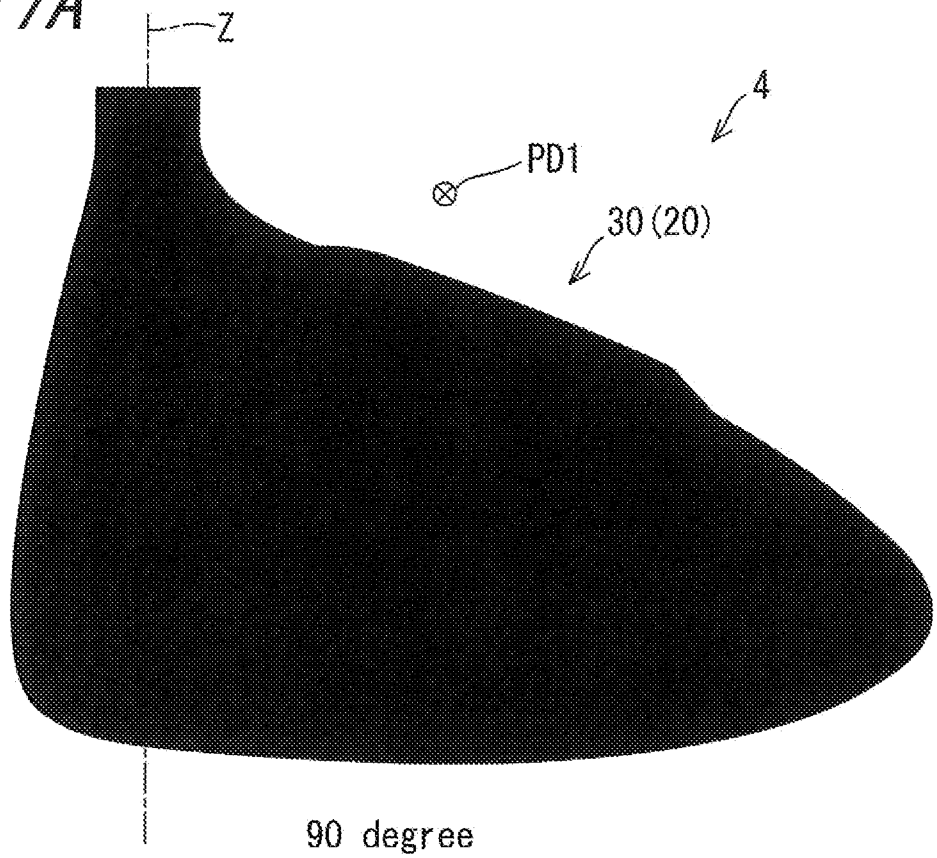
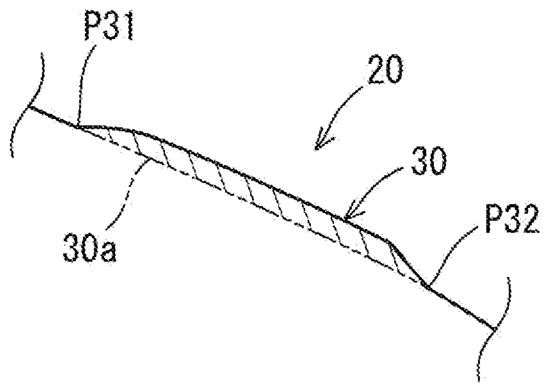


FIG. 17B



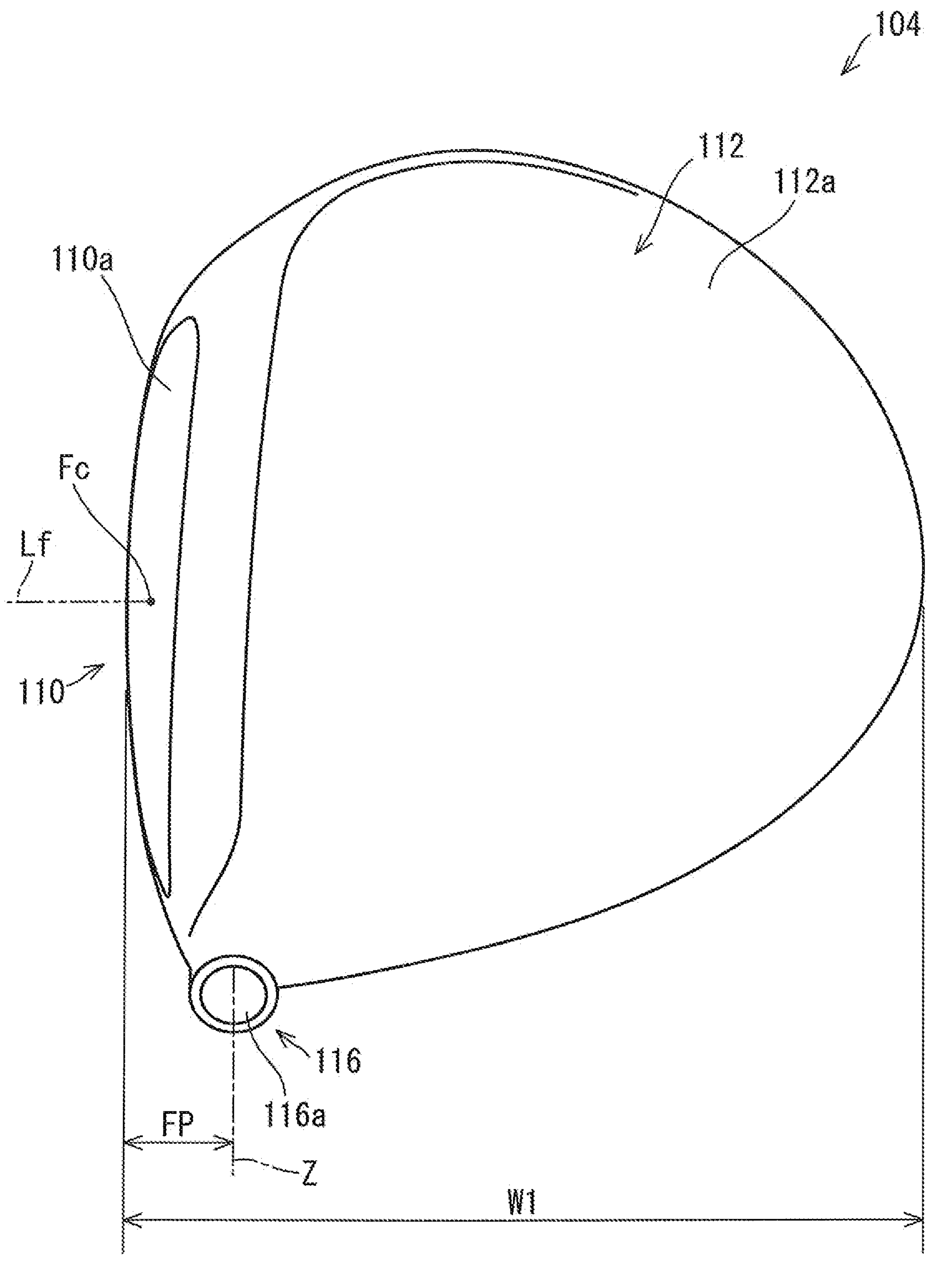


FIG. 18

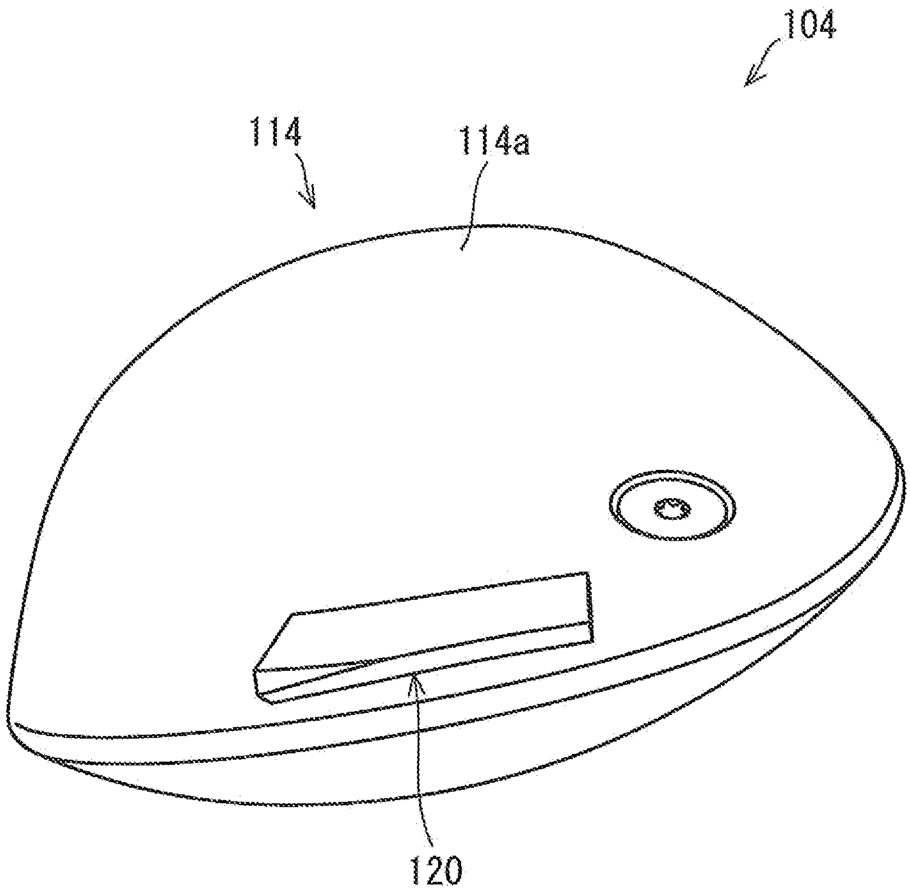


FIG. 19

FIG. 20A

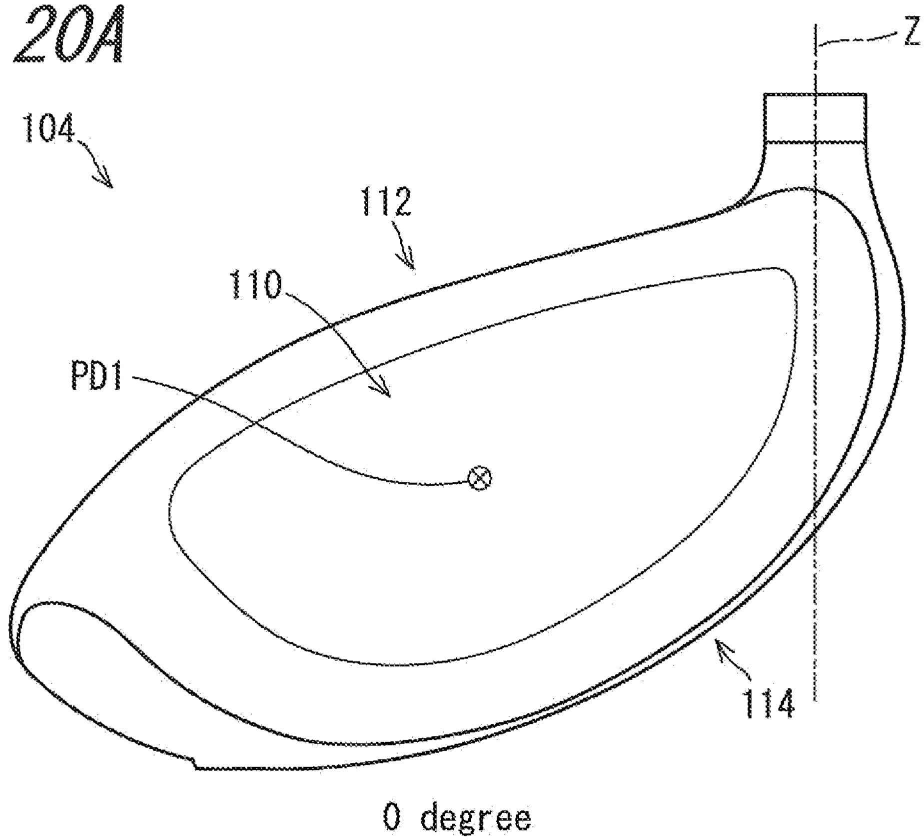


FIG. 20B

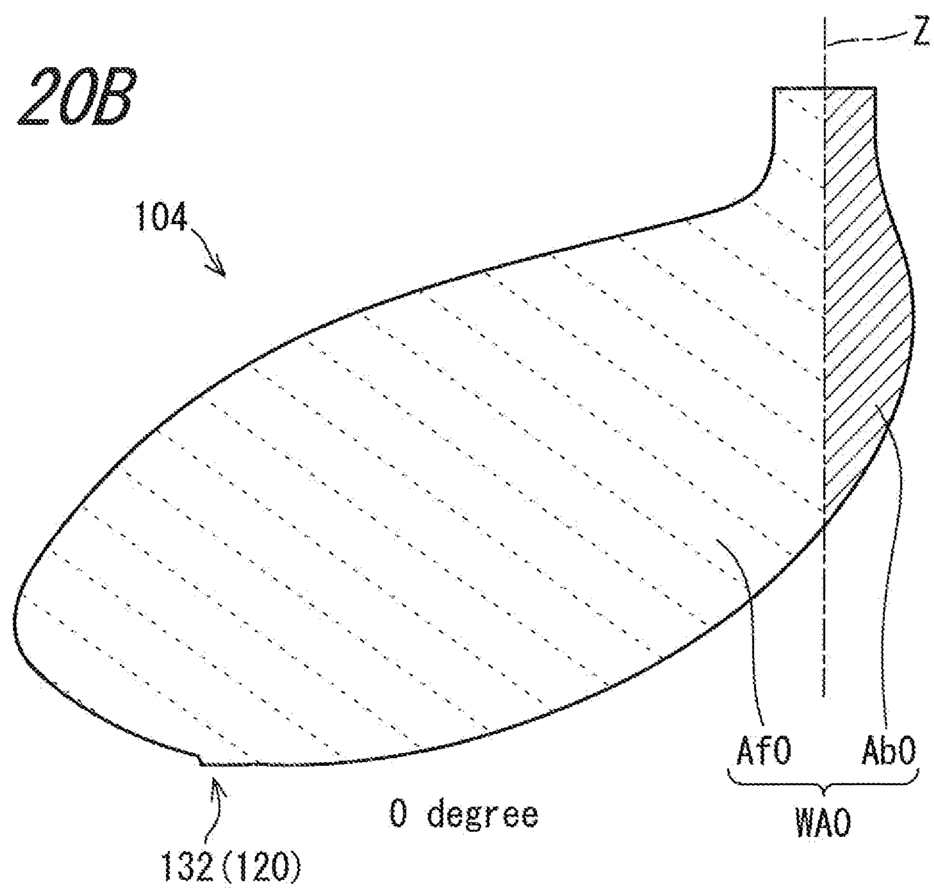


FIG. 21A

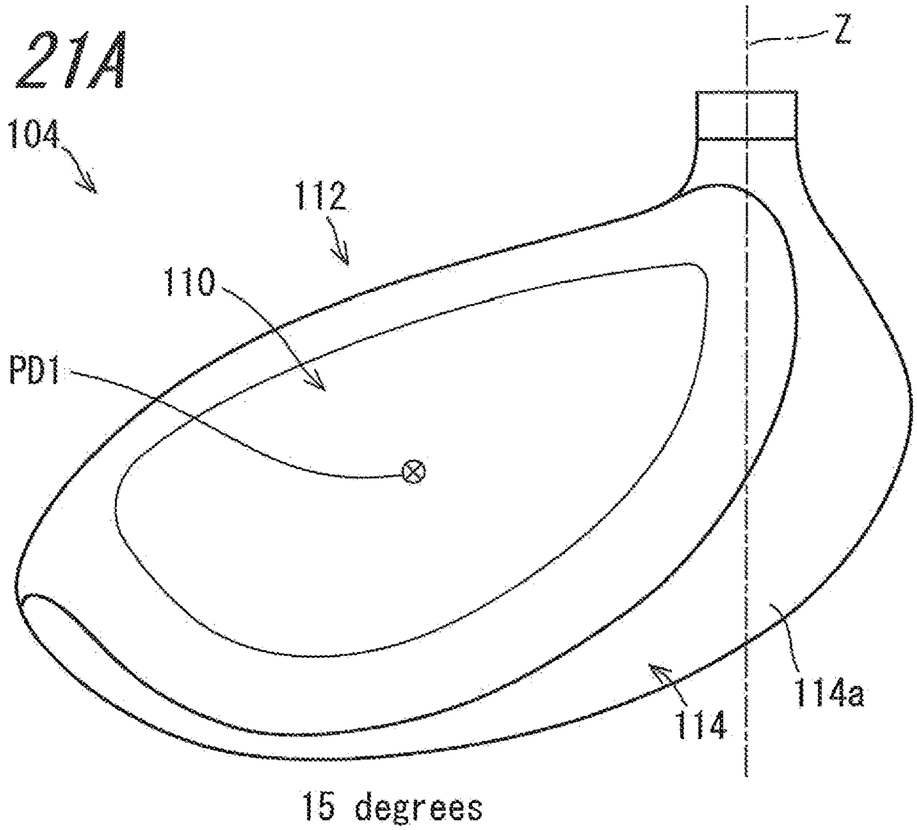


FIG. 21B

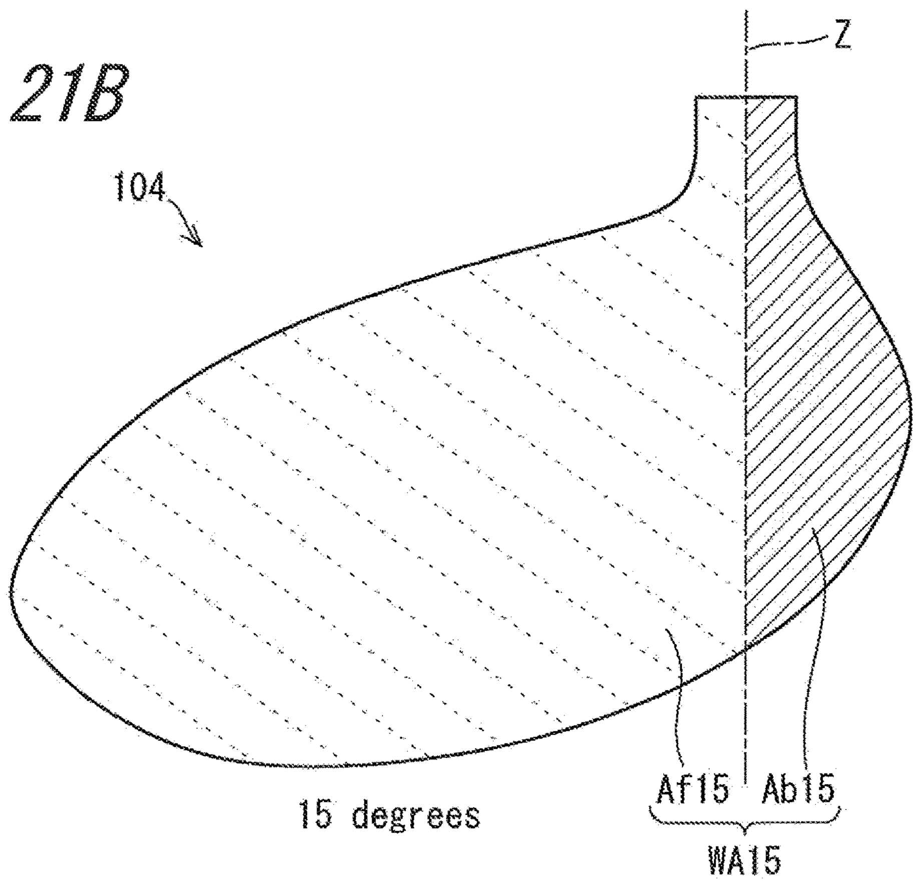


FIG. 22A

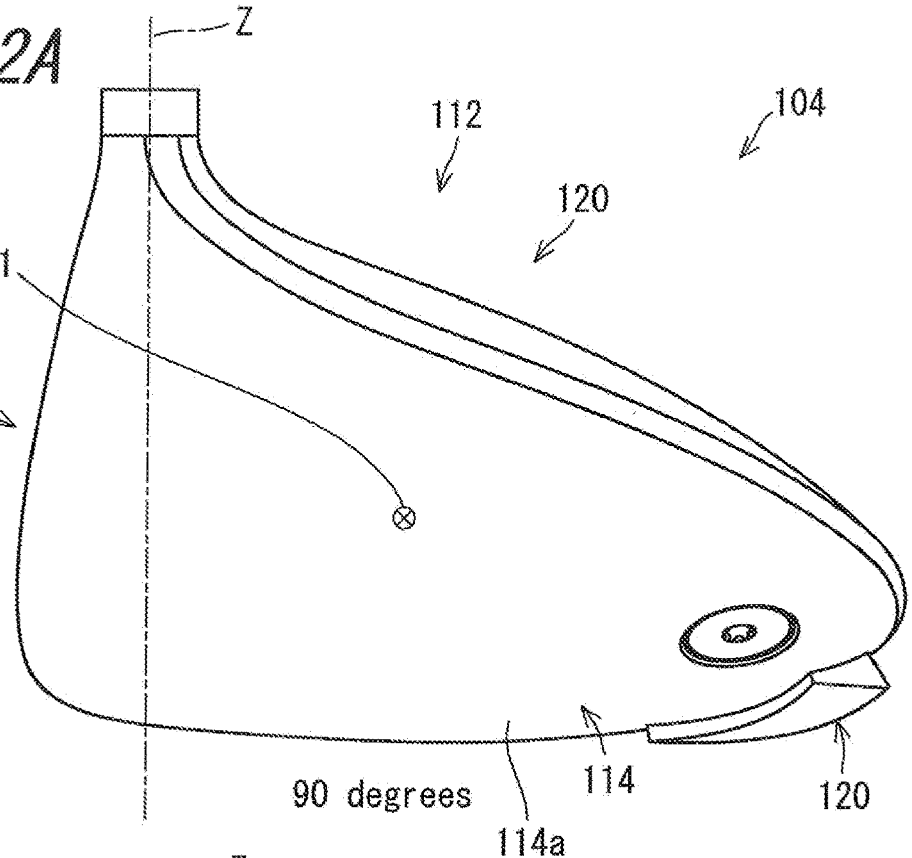
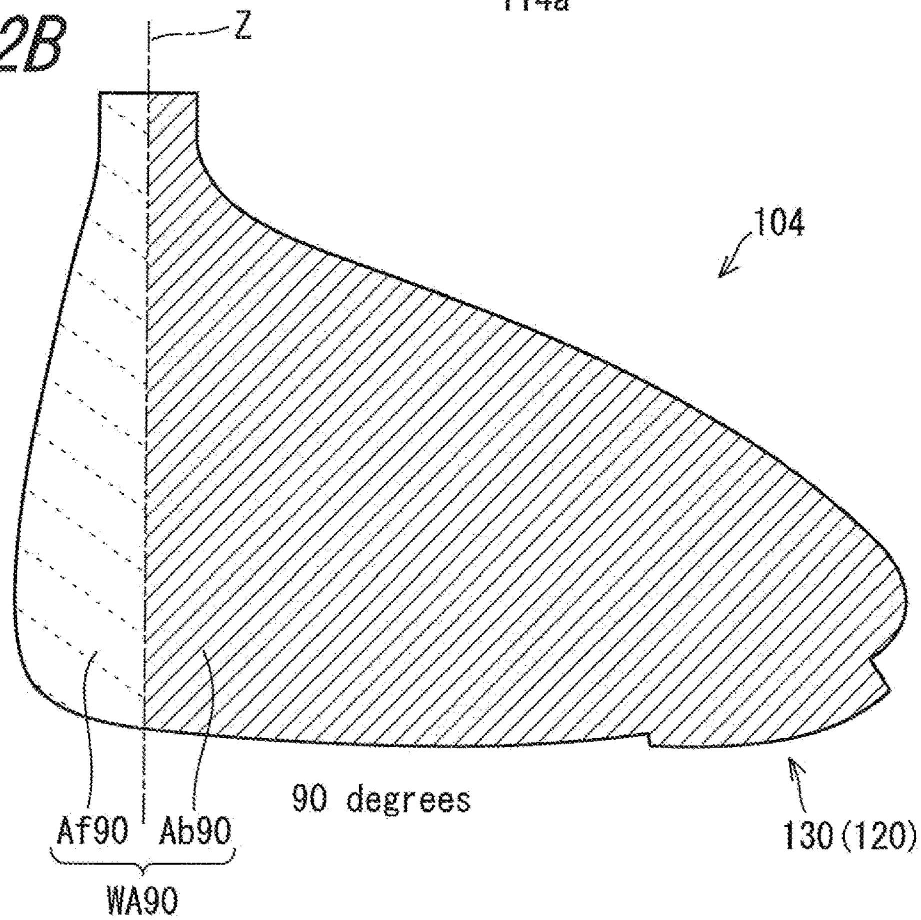


FIG. 22B



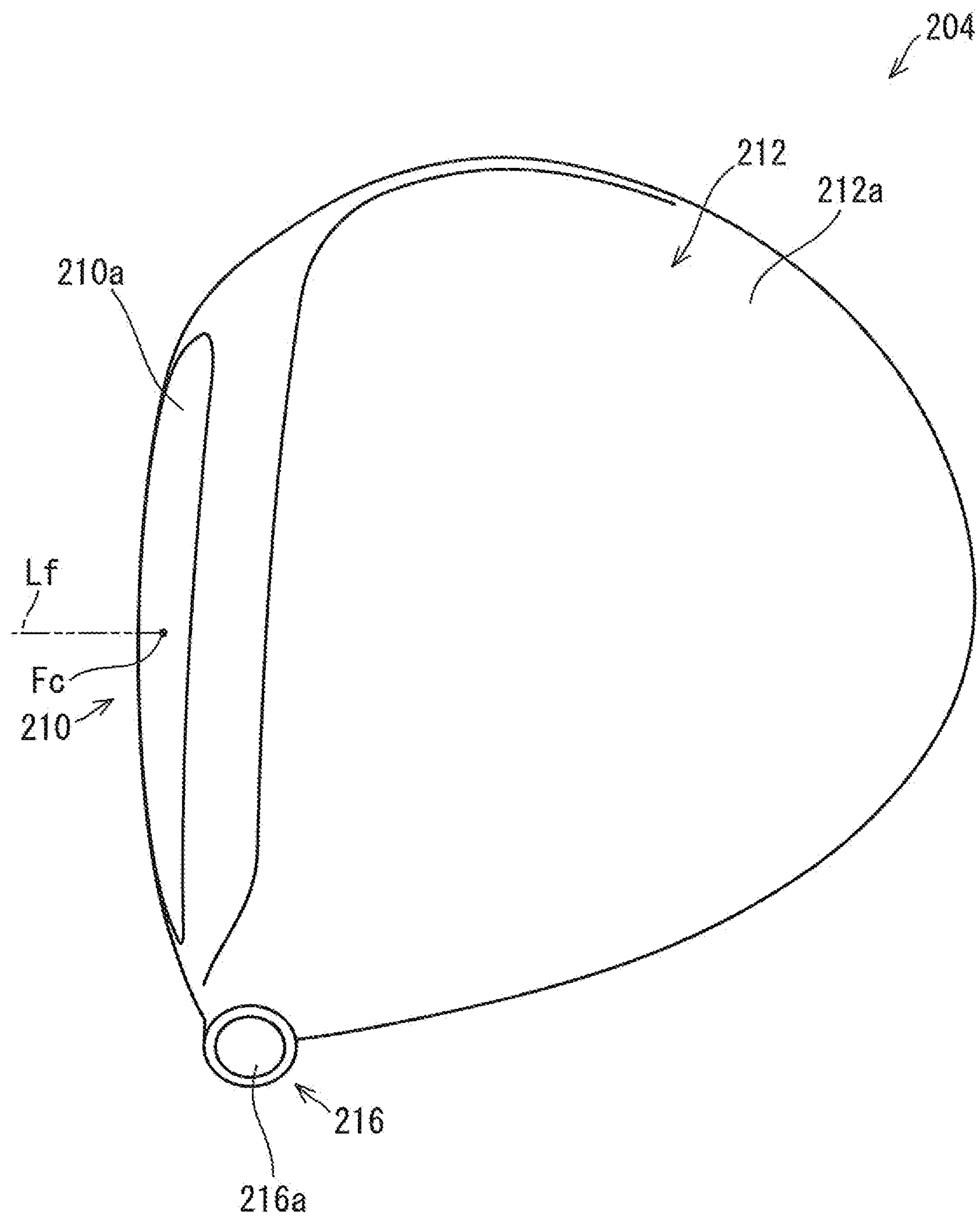


FIG. 23

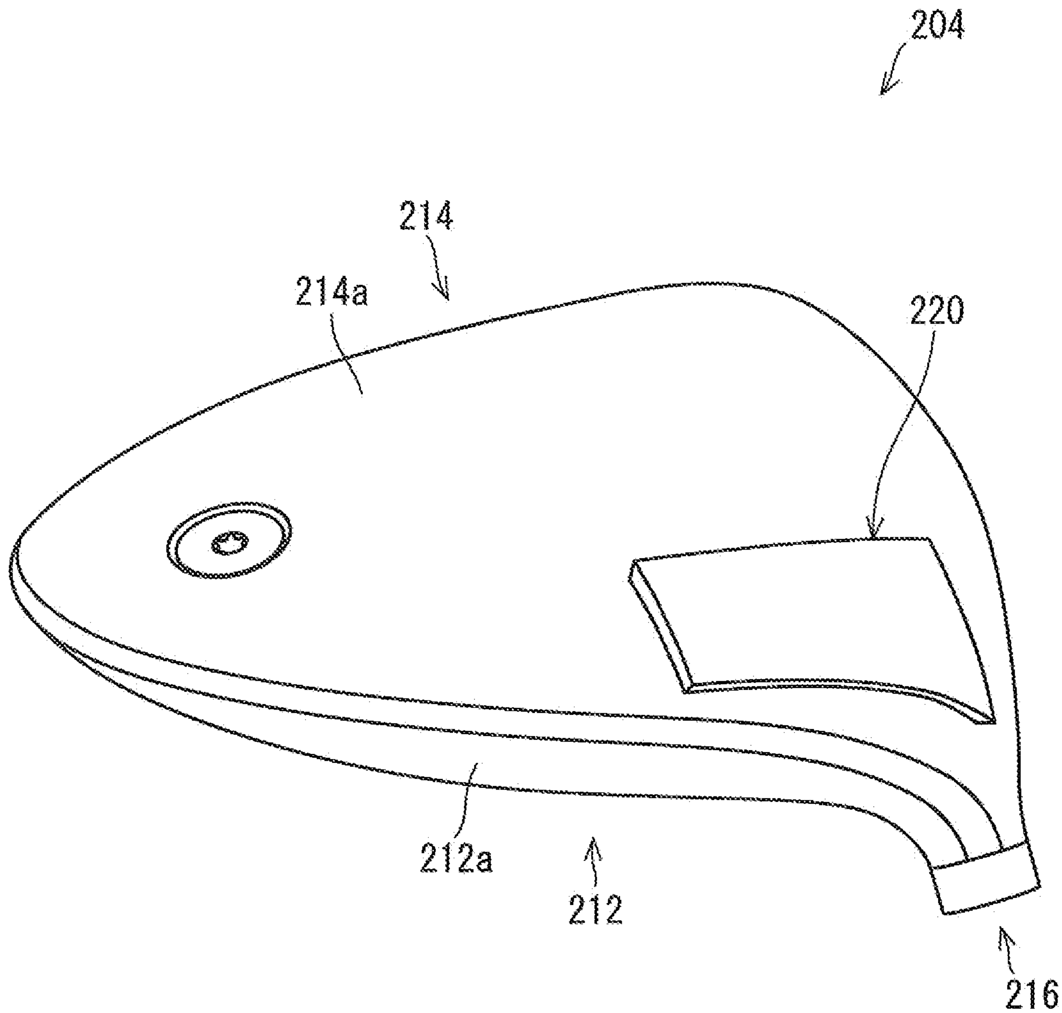


FIG. 24

FIG. 25A

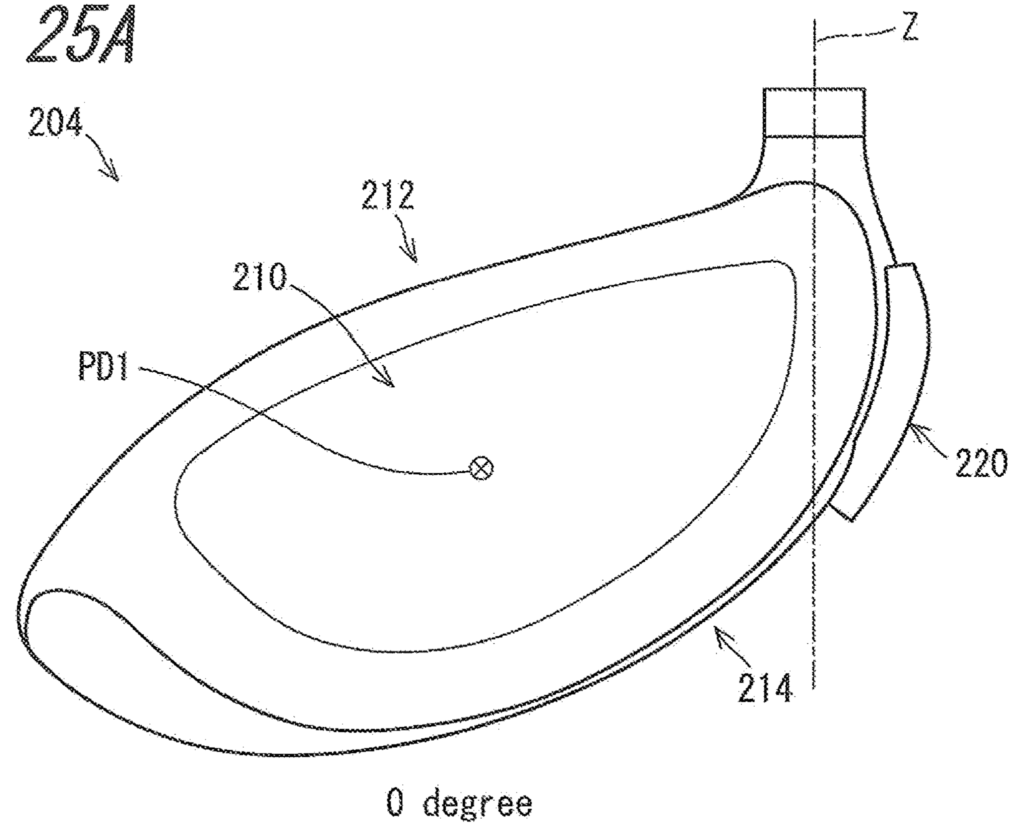


FIG. 25B

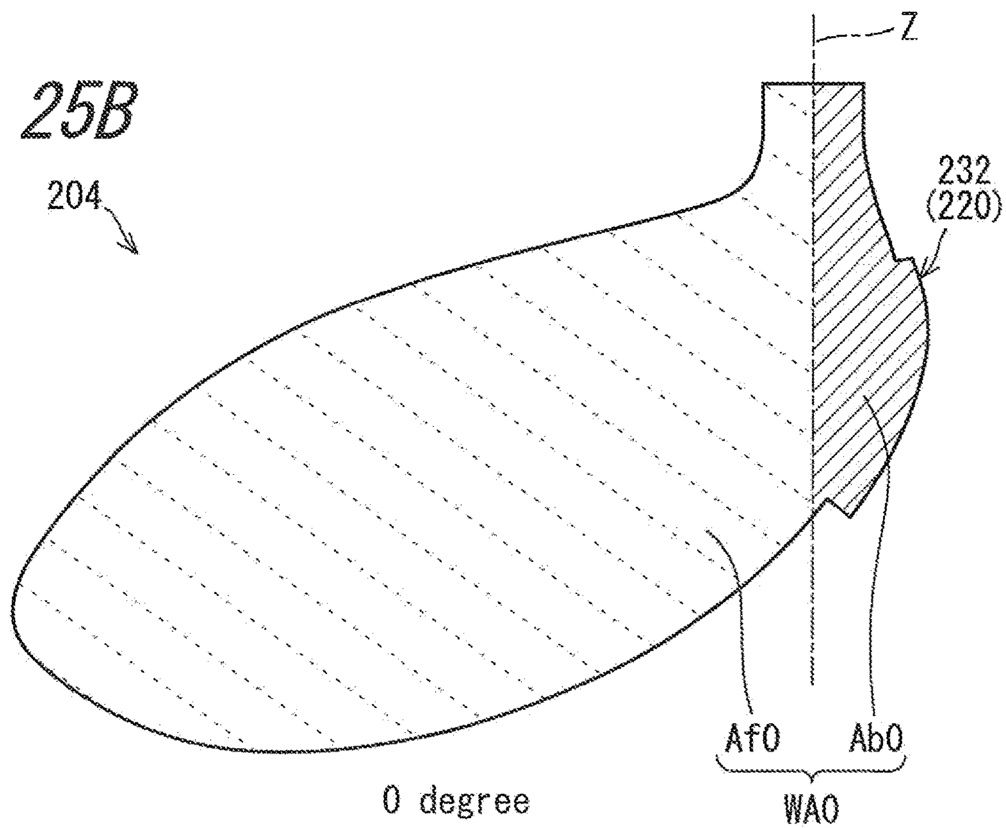


FIG. 26A

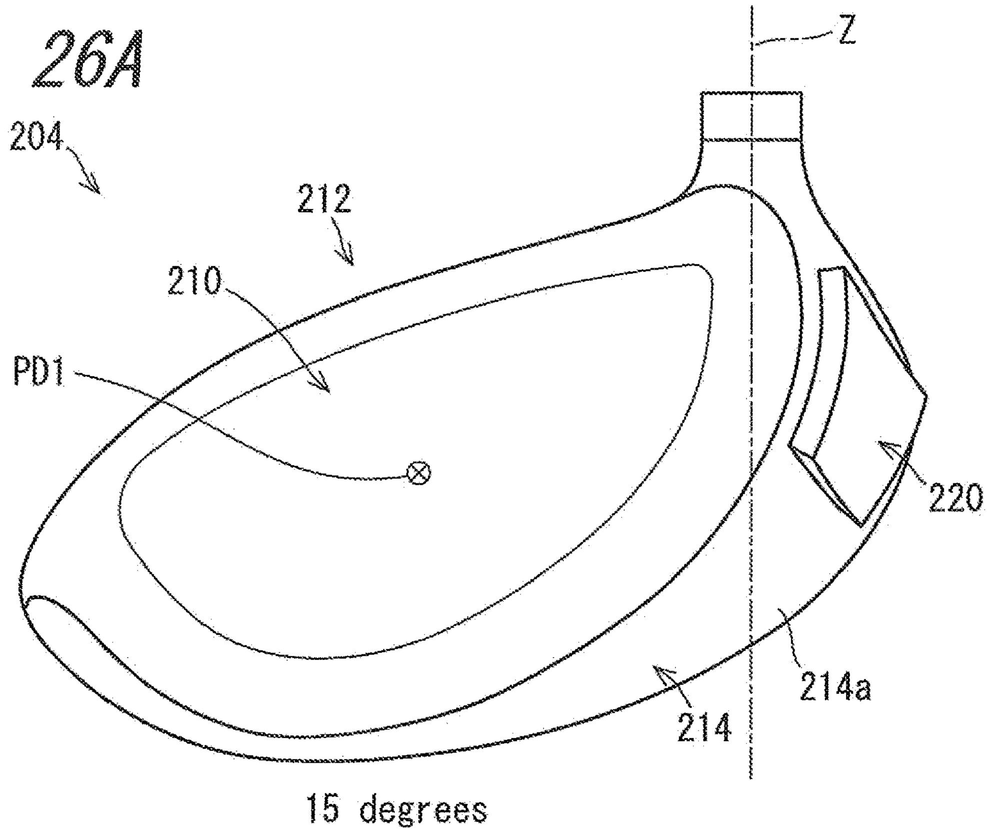


FIG. 26B

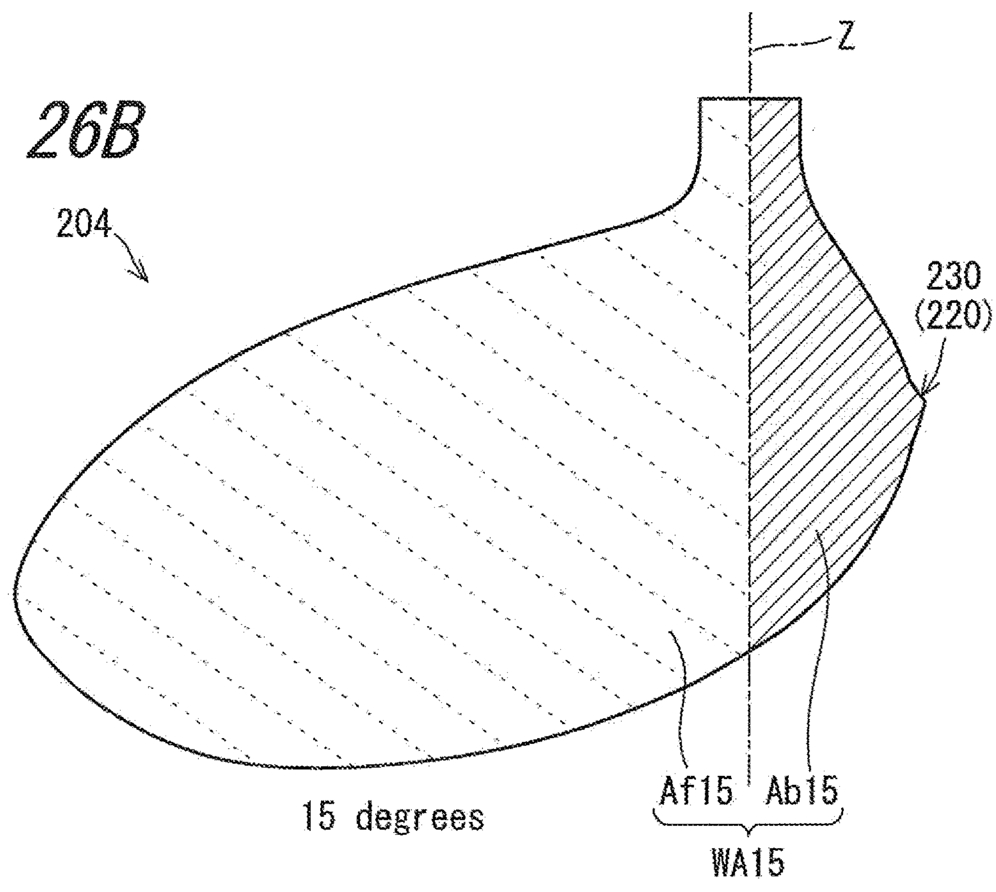


FIG. 27A

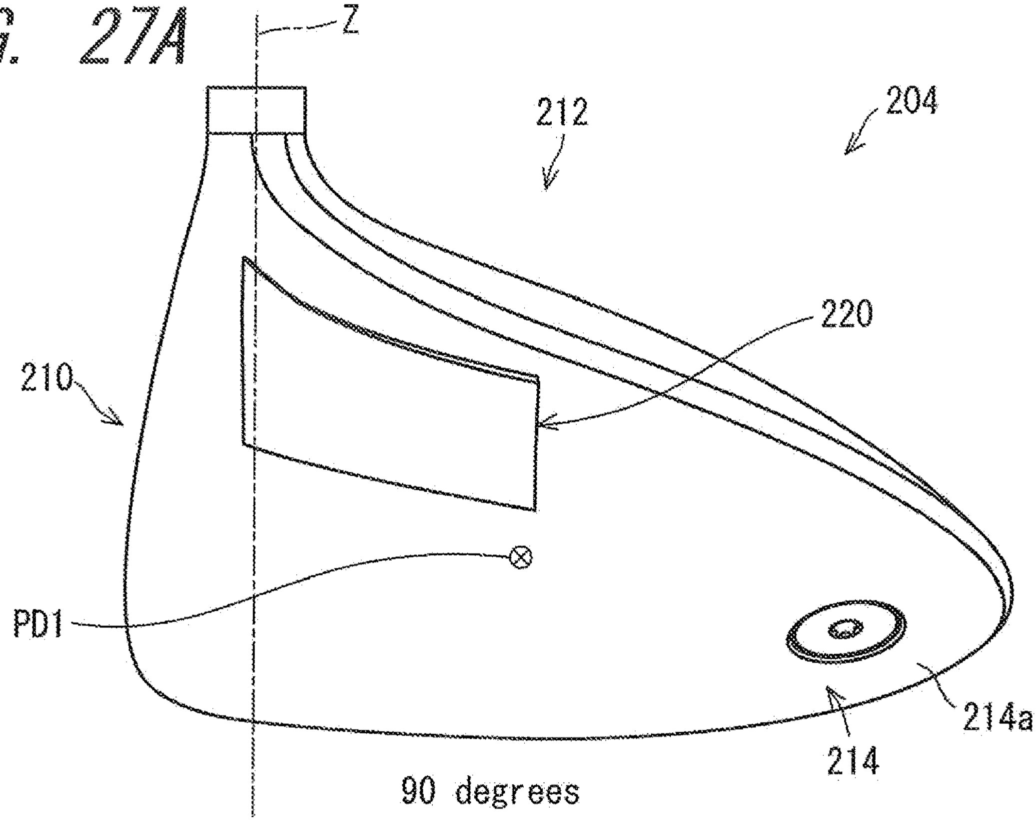
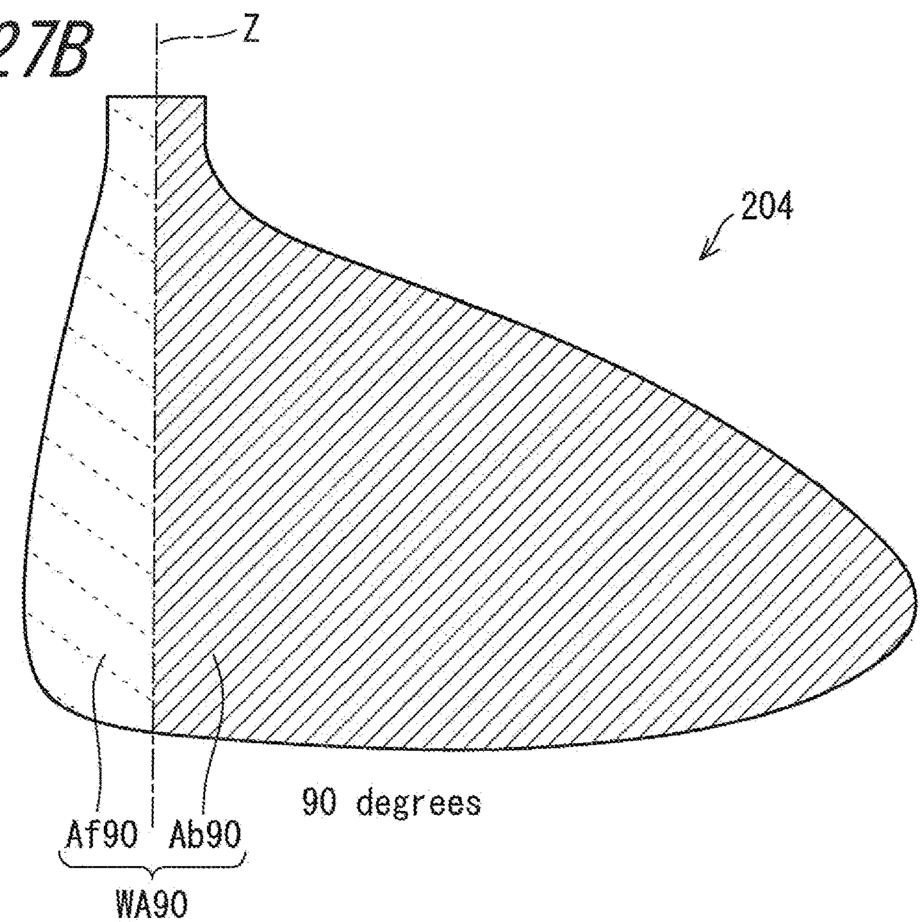


FIG. 27B



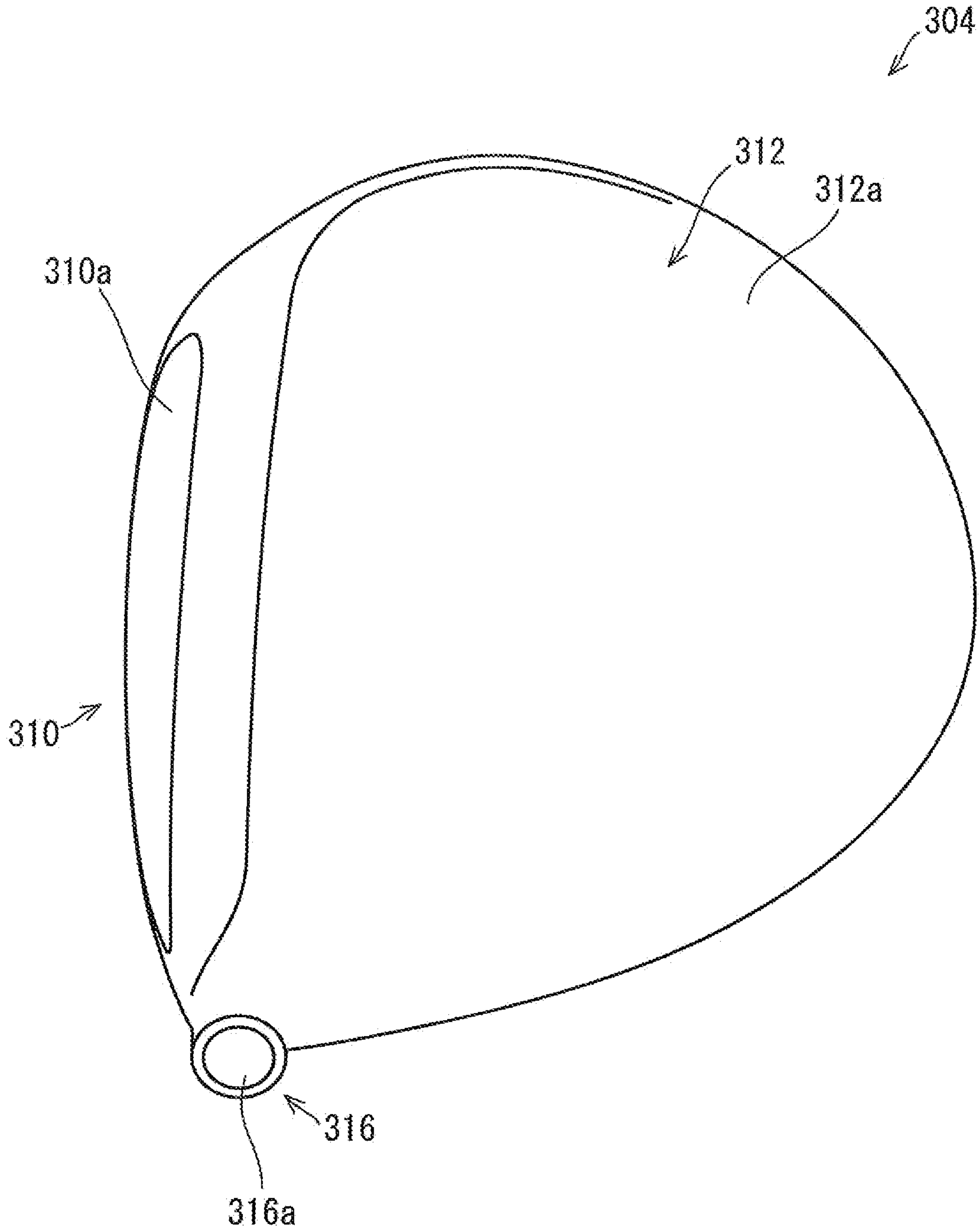


FIG. 28

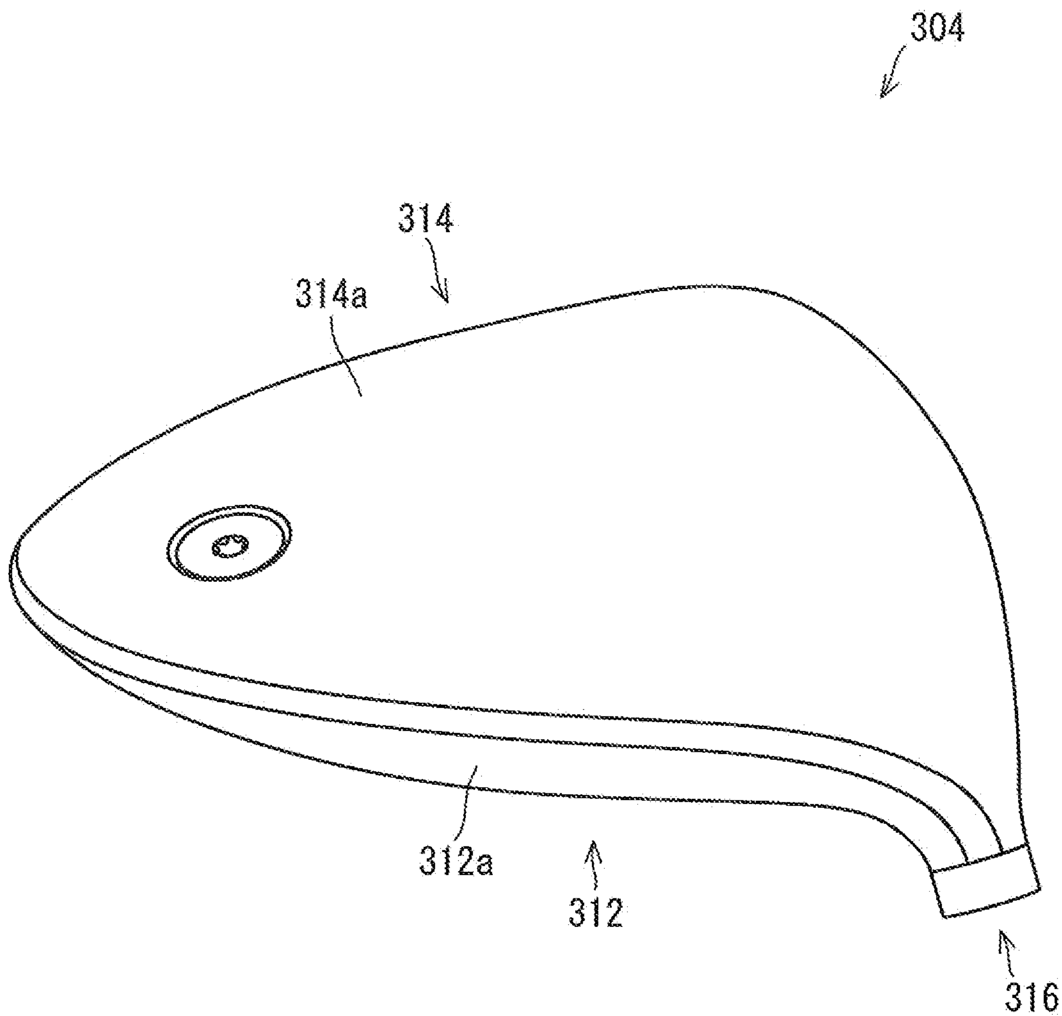


FIG. 29

FIG. 30A

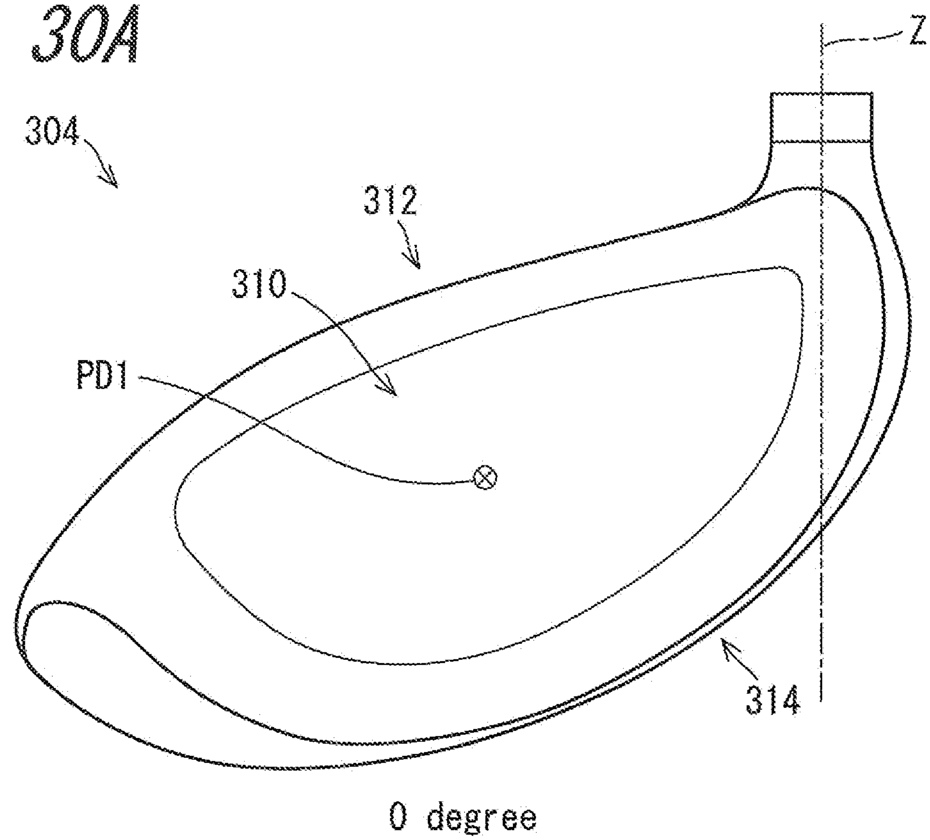


FIG. 30B

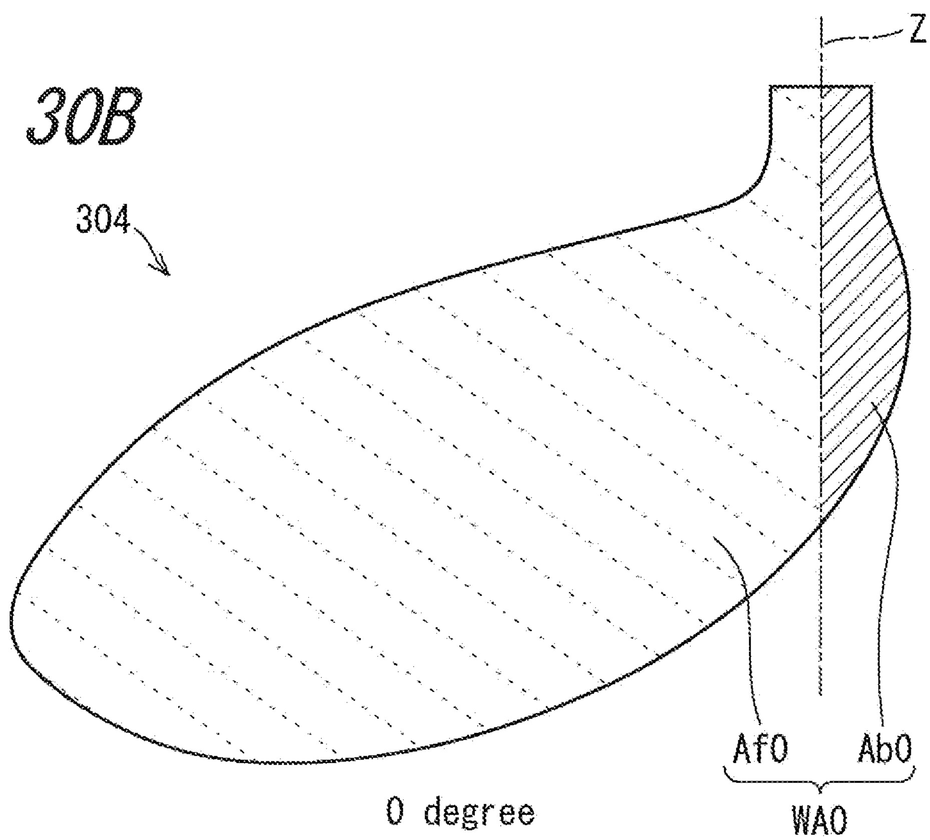


FIG. 31A

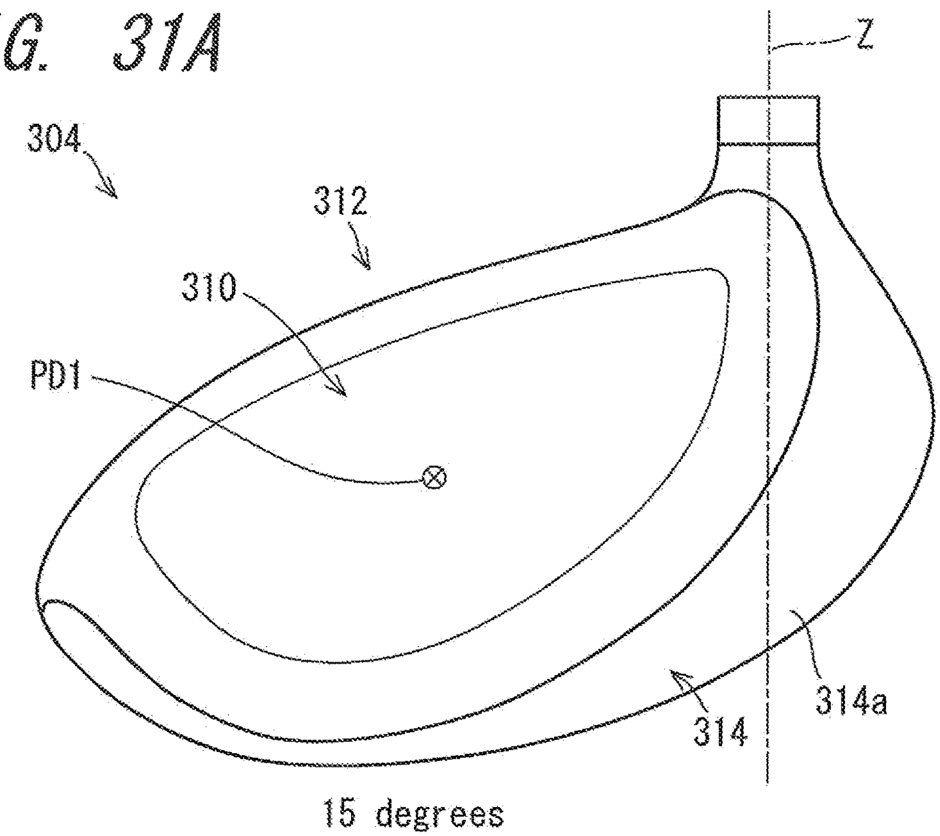


FIG. 31B

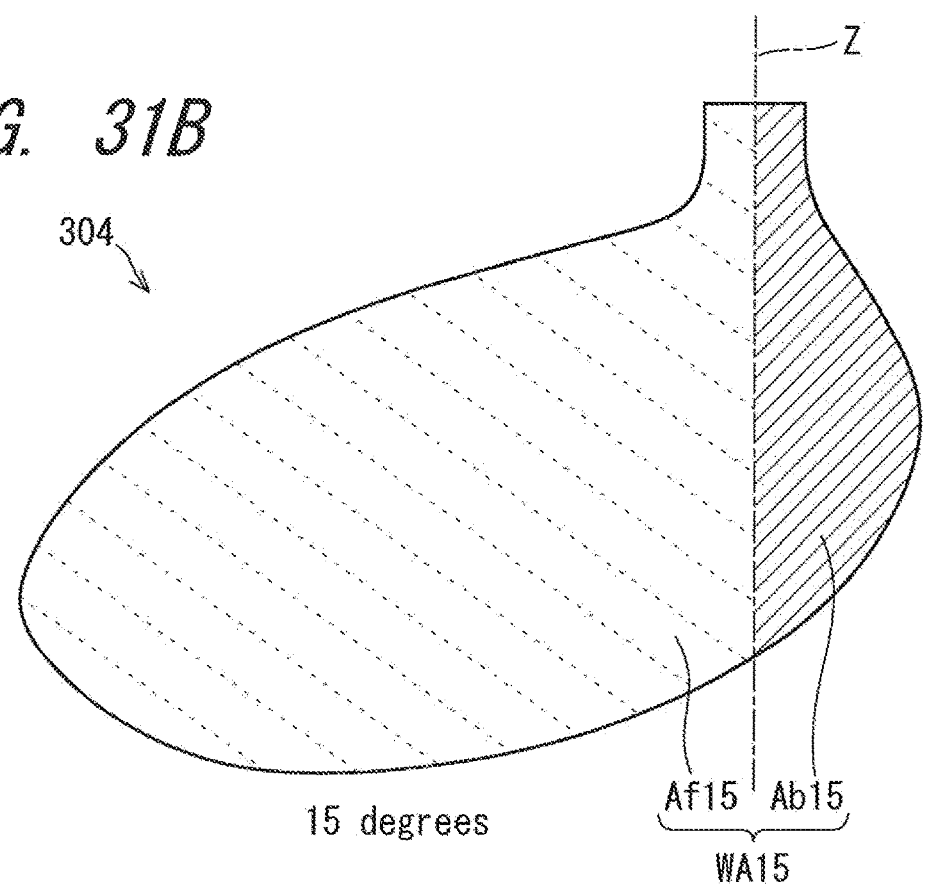


FIG. 32A

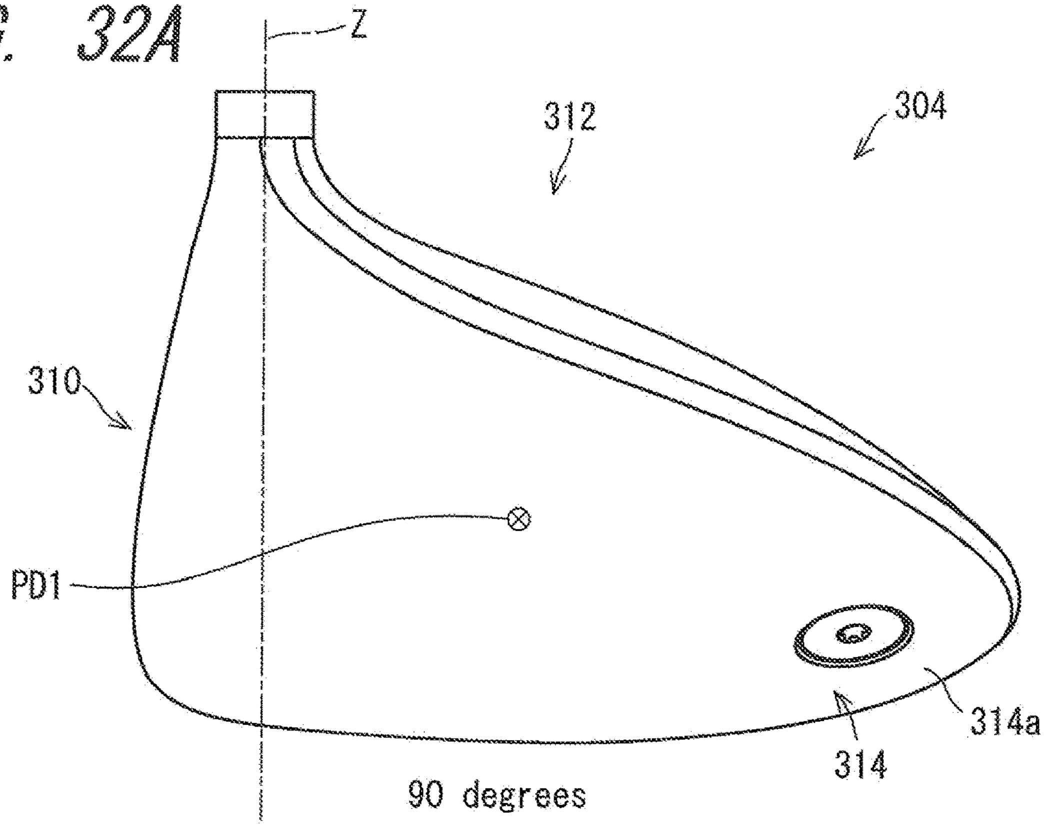
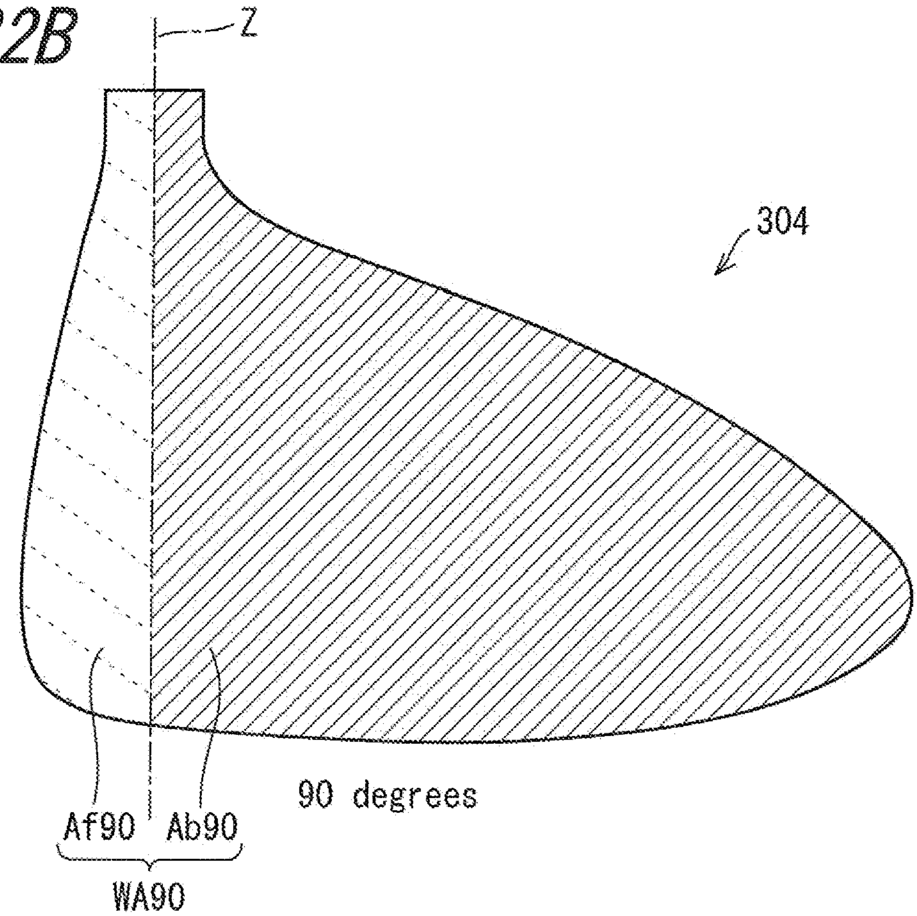


FIG. 32B



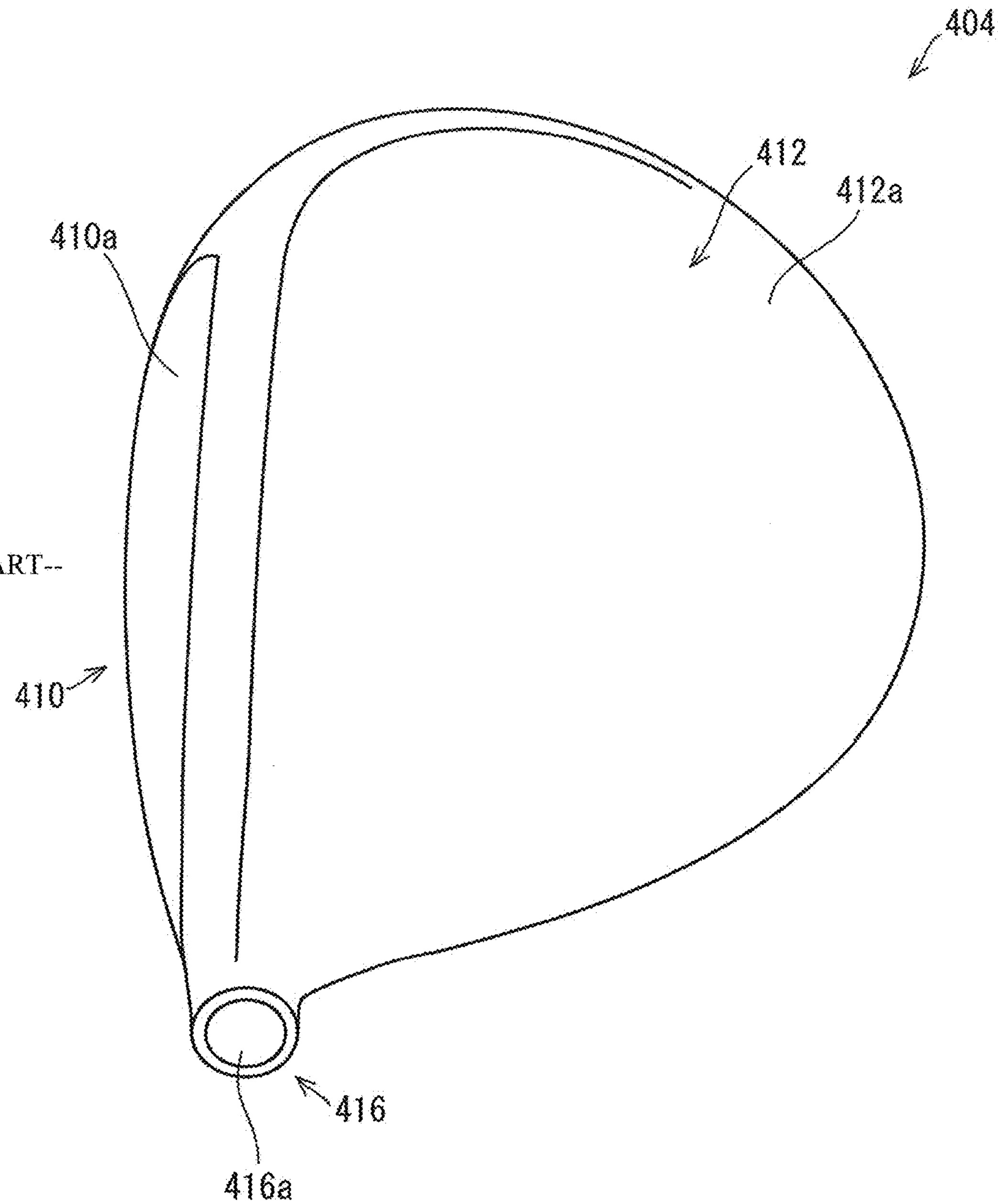
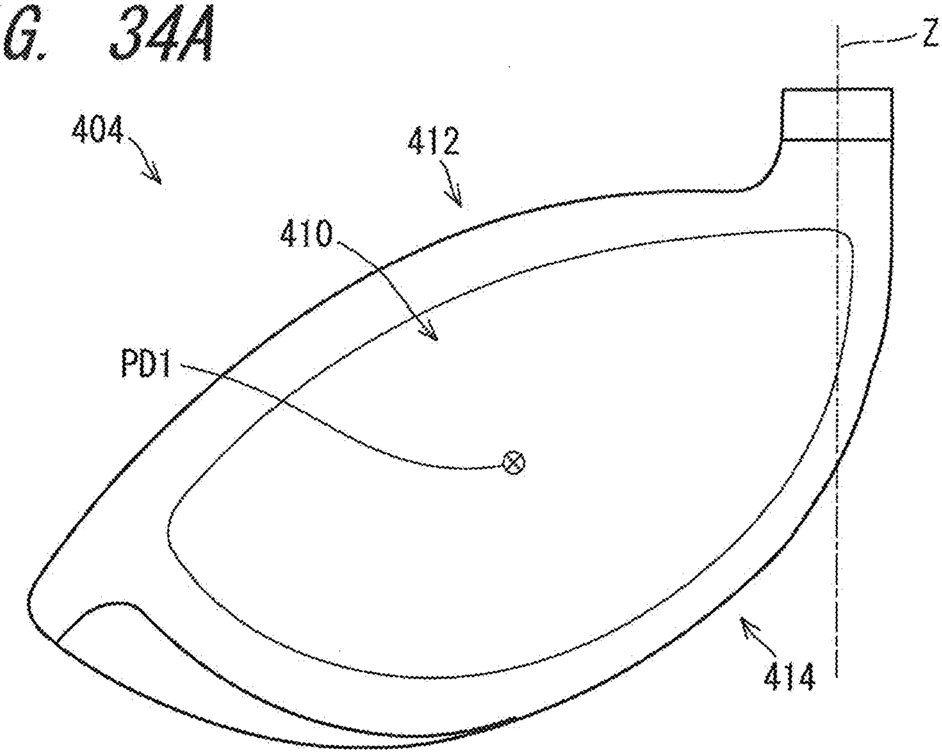


FIG. 33

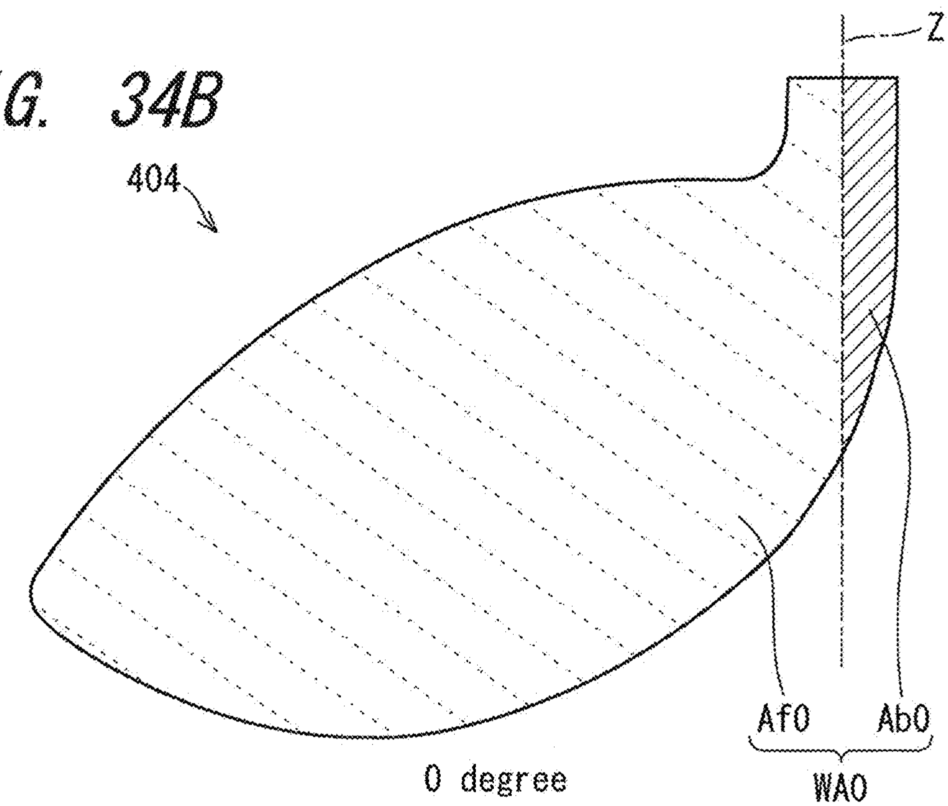
FIG. 34A



--PRIOR ART--

0 degree

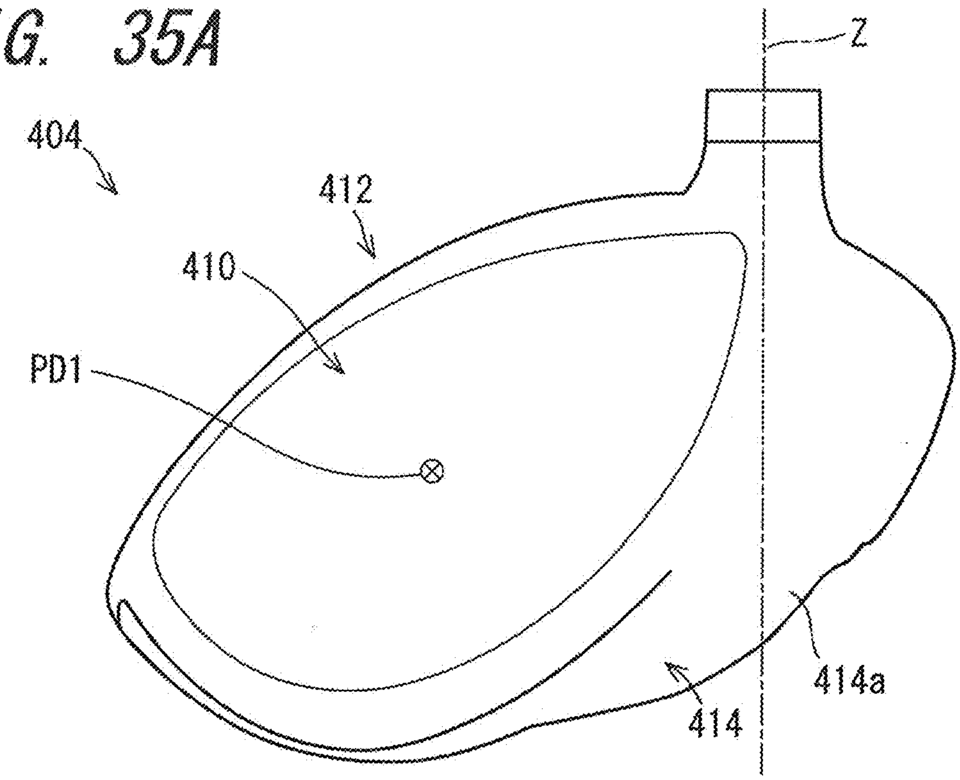
FIG. 34B



--PRIOR ART--

0 degree

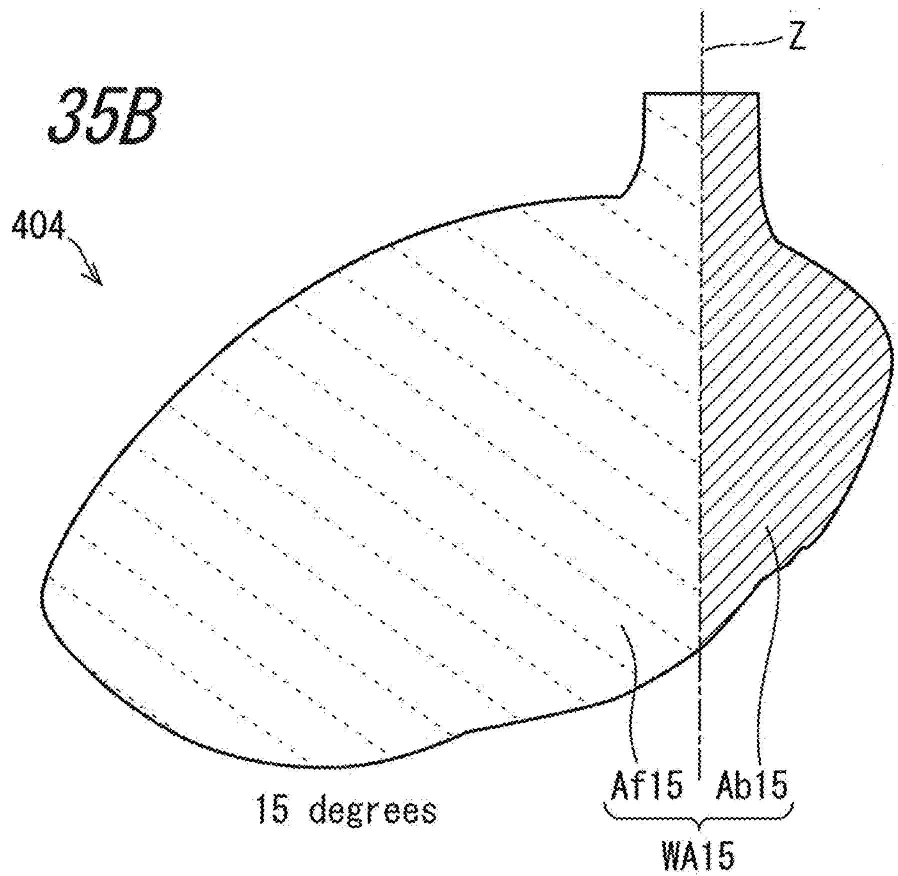
FIG. 35A



--PRIOR ART--

15 degrees

FIG. 35B



--PRIOR ART--

15 degrees

FIG. 36A

--PRIOR ART--

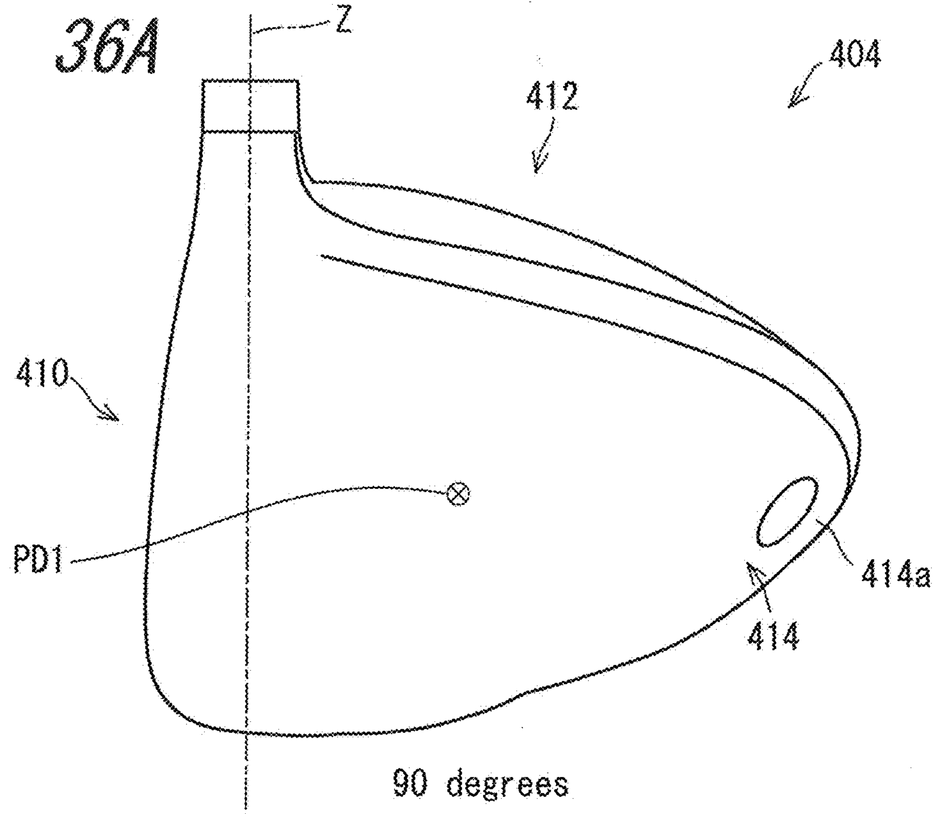
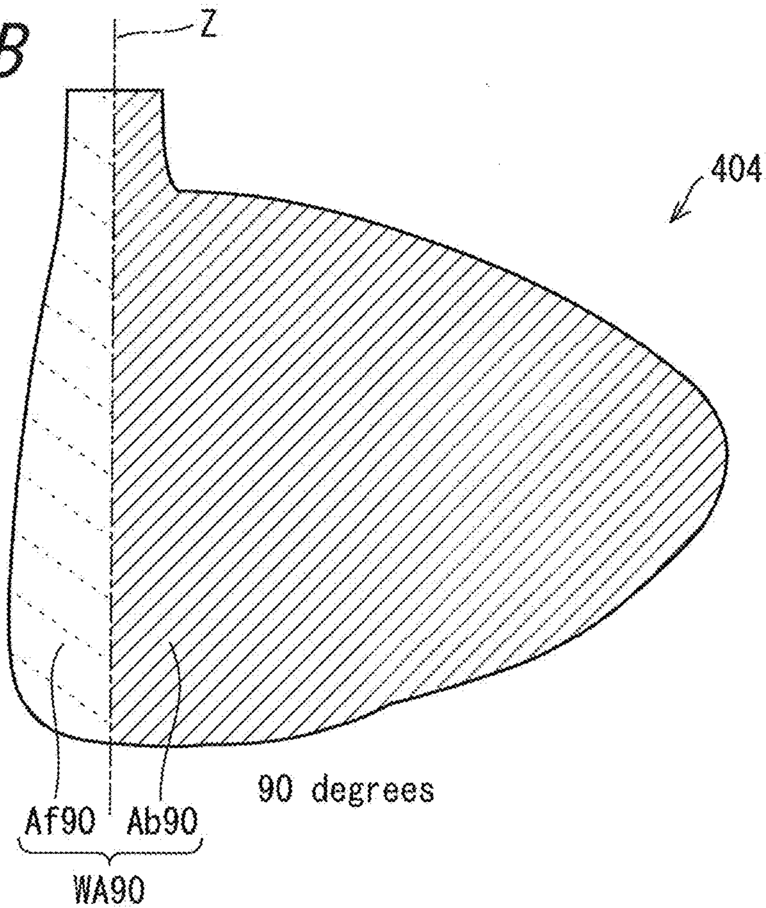


FIG. 36B

--PRIOR ART--



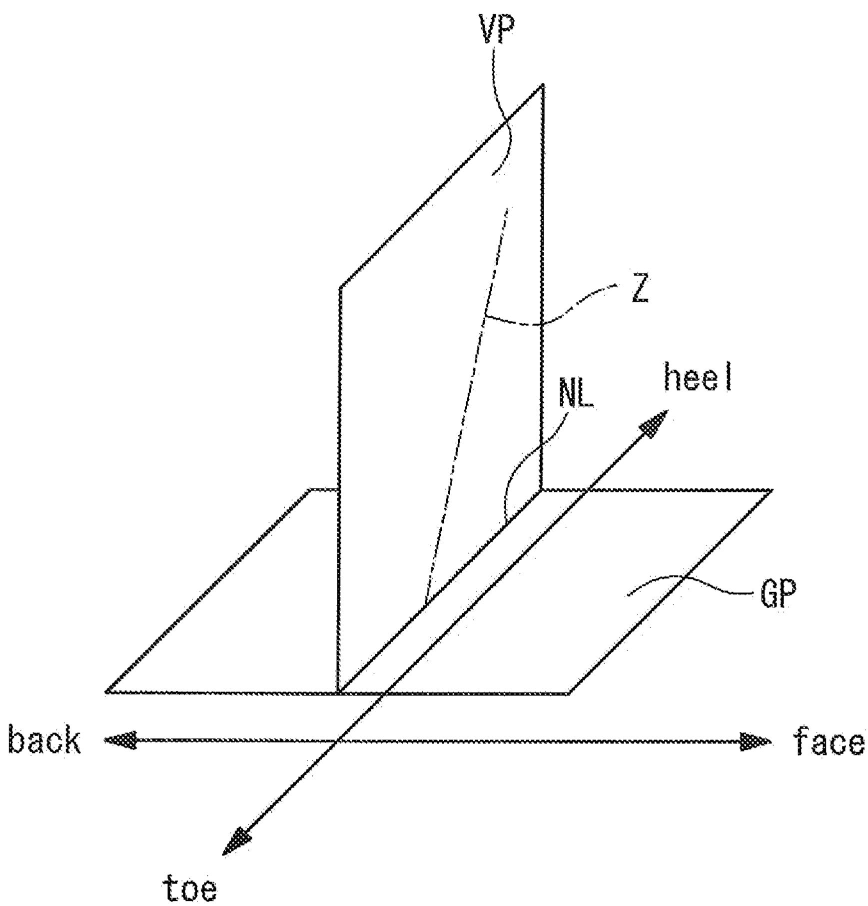


FIG. 37

GOLF CLUB HEAD

CROSS REFERENCE TO RELATED APPLICATION

The present application claims priority to Japanese Patent Application No. 2021-144283 filed on Sep. 3, 2021. The entire contents of this Japanese Patent Application are hereby incorporated by reference.

BACKGROUND

Technical Field

The present disclosure relates to a golf club head.

Description of the Related Art

A golf club having excellent flight distance performance is in demand. The flight distance performance can be improved by the performance of the head, the shaft, or the golf club as a whole. For an improvement of the flight distance performance based on the head, the position of the center of gravity and the rebound performance may be taken into consideration as described in, for example, JP2020-171434 A (US2020/0324173A1).

SUMMARY

Inventors of the present disclosure have found that a golf club head having excellent flight distance performance can be achieved based on a technical idea different from a conventional one.

One of the objects of the present disclosure is to provide a golf club head that has excellent ball catchability and excellent flight distance performance.

In one aspect, the present disclosure provides a golf club head including a face portion that forms a striking face, a crown portion that forms a crown outer surface, a sole portion that forms a sole outer surface, and a hosel portion that is configured to receive a shaft and that defines a shaft axis line. The striking face has a face center, and a normal line at the face center. The golf club head has a head width in a face-back direction of greater than or equal to 100 mm. The golf club head has a head length in a toe-heel direction of greater than or equal to 110 mm. A state of the head placed in such a manner that the shaft axis line is vertical to a horizontal plane and the normal line is parallel to a first perpendicular plane on which the shaft axis line lies is defined as a 0-degree state. A direction that is parallel to the first perpendicular plane and is parallel to the horizontal plane is defined as a projection direction. A projected area of the head projected in the projection direction when the head is rotated by θ° about the shaft axis line toward a back side from the 0-degree state is denoted by WAθ (mm^2). θ ranges from 0 to 90. The projected area is divided into two regions by the shaft axis line. Of the two regions, a region to which a force acting in such a direction that the striking face is opened is applied due to air resistance during downswing is defined as a first region, and a region to which a force acting in such a direction that the striking face is closed is applied due to the air resistance is defined as a second region. An area of the first region is denoted by Afθ (mm^2), and an area of the second region is denoted by Abθ (mm^2). (Afθ−Abθ) is denoted by Sθ (mm^2). **S90** is less than or equal to −4500 (mm^2). **S15** is less than or equal to 4700 (mm^2).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a golf club according to a first embodiment;

FIG. **2** is a front view of a head of the first embodiment as viewed from a face side, showing the head in a reference state;

FIG. **3** is a plan view of the head of the first embodiment as viewed from a crown side;

FIG. **4** is a perspective view of the head of the first embodiment as viewed from a heel back side;

FIG. **5** shows a cross-sectional contour line of the outer surface of the head in a cross-sectional view taken along line A-A in FIG. **3**;

FIG. **6** shows a cross-sectional contour line of the outer surface of the head in a cross-sectional view taken along line B-B in FIG. **3**;

FIG. **7** shows a cross-sectional contour line of the outer surface of the head in a cross-sectional view taken along line C-C in FIG. **3**;

FIG. **8** shows a cross-sectional contour line of the outer surface of the head in a cross-sectional view taken along line D-D in FIG. **3**;

FIG. **9** is an enlarged view of a portion surrounded by a tetragon Q**1** in FIG. **5**, and a virtually extended line of a base surface is additionally drawn in FIG. **9**;

FIG. **10** is an enlarged view of a portion surrounded by a tetragon Q**2** in FIG. **7**, and a virtually extended line of the base surface is additionally drawn in FIG. **10**;

FIG. **11**A shows the head in a 0-degree state as viewed from a face side, and FIG. **11**B shows the head in the 0-degree state as viewed from a heel side;

FIG. **12** shows a silhouette of a projection figure of the head in the 0-degree state;

FIG. **13**A is a projection figure of the head (of the first embodiment) in the 0-degree state, and FIG. **13**B shows a projected area of the head in the 0-degree state, the projected area being divided by a shaft axis line into a first region and a second region;

FIG. **14**A is a projection figure of the head (of the first embodiment) in a 15-degree state, and FIG. **14**B shows a projected area of the head in the 15-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **15**A is a projection figure of the head (of the first embodiment) in a 90-degree state, and FIG. **15**B shows a projected area of the head in the 90-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **16** shows the motion of a golf club during downswing;

FIG. **17**A shows a silhouette of a projection figure of the head in the 90-degree state, and FIG. **17**B illustrates an additional area provided by a silhouette protuberance;

FIG. **18** is a plan view of a head of a second embodiment as viewed from the crown side;

FIG. **19** is a perspective view of the head of the second embodiment, with its sole faced upward, as viewed from a back toe side;

FIG. **20**A is a projection figure of the head (of the second embodiment) in the 0-degree state, and FIG. **20**B shows a projected area of the head in the 0-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **21**A is a projection figure of the head (of the second embodiment) in the 15-degree state, and FIG. **21**B shows a projected area of the head in the 15-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **22**A is a projection figure of the head (of the second embodiment) in the 90-degree state, and FIG. **22**B shows a projected area of the head in the 90-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **23** is a plan view of a head of a third embodiment as viewed from the crown side;

FIG. **24** is a perspective view of the head of the third embodiment, with its sole faced upward, as viewed from the heel back side;

FIG. **25**A is a projection figure of the head (of the third embodiment) in the 0-degree state, and FIG. **25**B shows a projected area of the head in the 0-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **26**A is a projection figure of the head (of the third embodiment) in the 15-degree state, and FIG. **26**B shows a projected area of the head in the 15-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **27**A is a projection figure of the head (of the third embodiment) in the 90-degree state, and FIG. **27**B shows a projected area of the head in the 90-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **28** is a plan view of a head of Reference Example as viewed from the crown side;

FIG. **29** is a perspective view of the head of Reference Example, with its sole faced upward, as viewed from the heel back side;

FIG. **30**A is a projection figure of the head (of Reference Example) in the 0-degree state, and FIG. **30**B shows a projected area of the head in the 0-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **31**A is a projection figure of the head (of Reference Example) in the 15-degree state, and FIG. **31**B shows a projected area of the head in the 15-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **32**A is a projection figure of the head (of Reference Example) in the 90-degree state, and FIG. **32**B shows a projected area of the head in the 90-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **33** is a plan view of a head of Comparative Example 6 as viewed from the crown side;

FIG. **34**A is a projection figure of the head (of Comparative Example 6) in the 0-degree state, and FIG. **34**B shows a projected area of the head in the 0-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **35**A is a projection figure of the head (of Comparative Example 6) in the 15-degree state, and FIG. **35**B shows a projected area of the head in the 15-degree state, the projected area being divided by the shaft axis line into a first region and a second region;

FIG. **36**A is a projection figure of the head (of Comparative Example 6) in the 90-degree state, and FIG. **36**B shows a projected area of the head in the 90-degree state, the projected area being divided by the shaft axis line into a first region and a second region; and

FIG. **37** is a conceptual diagram for illustrating the reference state.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the present disclosure will be described in detail according to the preferred embodiments with appropriate references to the accompanying drawings.

In the present disclosure, a reference state, a reference perpendicular plane, a toe-heel direction, a face-back direction, an up-down direction, a face center, and a normal line at the face center are defined as follows.

The reference state is a state where a head is placed at a predetermined lie angle on a ground plane GP. As shown in FIG. **37**, in this reference state, a shaft axis line Z lies on a plane VP that is perpendicular to the ground plane GP. The shaft axis line Z is the center line of a shaft when the shaft is attached to the head. Typically, the shaft axis line Z is the center line of a hosel hole (shaft hole). The plane VP is defined as the reference perpendicular plane. The predetermined lie angle is shown in a product catalog, for example.

In this reference state, a face orientation is determined so that the normal line of a striking face at the face center is contained in (lies on) a plane that is perpendicular to the reference perpendicular plane VP and is perpendicular to the ground plane GP. That is, in a planar view of the head as viewed from above, the normal line of the striking face at the face center is set to be perpendicular to the reference perpendicular plane VP.

In the present disclosure, the toe-heel direction is the direction of an intersection line NL between the reference perpendicular plane VP and the ground plane GP (see FIG. **37**).

In the present disclosure, the face-back direction is a direction that is perpendicular to the toe-heel direction and is parallel to the ground plane GP.

In the present disclosure, the up-down direction is a direction that is perpendicular to the toe-heel direction and is perpendicular to the face-back direction. In other words, the up-down direction in the present disclosure is a direction perpendicular to the ground plane GP.

In the present disclosure, the face center Fc is determined in the following manner. First, a point Pr is selected roughly at the center of a striking face in the up-down direction and the toe-heel direction. Next, a plane that passes through the point Pr, extends in the direction of a line normal to the striking face at the point Pr, and is parallel to the toe-heel direction is determined. An intersection line between this plane and the striking face is drawn, and a midpoint Px of this intersection line is determined. Next, a plane that passes through the midpoint Px, extends in the direction of a line normal to the striking face at the midpoint Px, and is parallel to the up-down direction is determined. An intersection line between this plane and the striking face is drawn, and a midpoint Py of this intersection line is determined. Next, a plane that passes through the midpoint Py, extends in the direction of a line normal to the striking face at the midpoint Py, and is parallel to the toe-heel direction is determined. An intersection line between this plane and the striking face is drawn, and a midpoint Px of this intersection line is newly determined. Next, a plane that passes through this newly-determined midpoint Px, extends in the direction of a line normal to the striking face at this midpoint Px, and is parallel to the up-down direction is determined. An intersection line between this plane and the striking face is drawn, and a midpoint Py of this intersection line is newly determined. By repeating the above-described steps, points Px and Py are sequentially determined. In the course of repeating these steps, when the distance between a newly-determined midpoint Py and a midpoint Py determined in the immediately preceding step becomes less than or equal to 0.5 mm for the first time, the newly-determined midpoint Py (the midpoint Py determined last) is defined as the face center Fc.

FIG. **1** is an overall view of a golf club **2** that includes a head **4** according to a first embodiment of the present disclosure. FIG. **2** is a front view of the head **4**. FIG. **2** shows the head **4** which is in the reference state as viewed from the face side. FIG. **3** is a plan view of the head **4** as viewed from a crown side. FIG. **4** is a perspective view of the head **4** as viewed from the heel back side.

As shown in FIG. **1**, the golf club **2** includes the golf club head **4**, a shaft **6**, and a grip **8**. The shaft **6** has a tip end Tp and a butt end Bt. The head **4** is attached to a tip end portion of the shaft **6**. The grip **8** is attached to a butt end portion of the shaft **6**.

The golf club **2** is a driver (No. 1 wood). Typically, the club as a driver has a length of greater than or equal to 43 inches. Preferably, the golf club **2** is a wood-type golf club.

The shaft **6** is in a tubular form. The shaft **6** is hollow. The material of the shaft **6** is a fiber reinforced resin. The shaft **6** is a so-called carbon shaft. Preferably, the shaft **6** is formed with a cured prepreg sheet. In the prepreg sheet, fibers are substantially oriented in one direction. Such a prepreg in which fibers are substantially oriented in one direction is also referred to as UD prepreg. "UD" is an abbreviation of "unidirectional". A prepreg other than the UD prepreg may be used. For example, fibers contained in the prepreg sheet may be woven. The shaft **6** may include a metal wire. The material of the shaft **6** is not limited, and may be a metal, for example.

The grip **8** is a part that a golfer grips during a swing. Examples of the material of the grip **8** include rubber compositions and resin compositions. The rubber composition for the grip **8** may contain air bubbles.

Although not shown in the drawings, the head **4** is hollow. In the present embodiment, the head **4** is a wood type head. The head **4** is a driver head. Examples of a preferable material for the head **4** include metals and fiber reinforced plastics. Examples of the metals include titanium alloys, pure titanium, stainless steel, maraging steel, and soft iron. Examples of the fiber reinforced plastics include carbon fiber reinforced plastics. The head **4** may be a composite head including a metal portion and a non-metal portion. Examples of the material for the non-metal portion include fiber reinforced plastics. From the viewpoint of strength, the fiber reinforced plastic is preferably a carbon fiber reinforced plastic.

As shown in FIG. **2** to FIG. **4**, the head **4** includes a face portion **10**, a crown portion **12**, a sole portion **14**, and a hosel portion **16**. The face portion **10** includes a striking face **10***a*. The striking face **10***a* is the outer surface of the face portion **10**. The striking face **10***a* is also simply referred to as a face. The crown portion **12** forms a crown outer surface **12***a*. The sole portion **14** forms a sole outer surface **14***a*. The hosel portion **16** has a shaft hole **16***a*.

The striking face **10***a* has a face center Fc as defined above. The striking face **10***a* has a normal line Lf. The normal line Lf is a line normal to the striking face **10***a* at the face center Fc.

The head **4** includes, on its outer surface, a protruding portion **20**. In the present embodiment, the protruding portion **20** is formed on the crown portion **12**. The crown portion **12** includes the protruding portion **20** on the crown outer surface **12***a*. Although not shown in the drawings, the protruding portion **20** is hollow. The protruding portion **20** forms a projection on the crown outer surface **12***a* and forms a recess on a crown inner surface. Alternatively, the protruding portion **20** may be solid (not hollow).

The entirety of the protruding portion **20** is positioned on the heel side with respect to the face center Fc. In the planar view, the entirety of the protruding portion **20** is positioned on the heel side with respect to a geometric center CR.

In the front view of the head as viewed from the face side (see FIG. **2**), the protruding portion **20** is not viewable. In the front view of the head as viewed from the face side (see FIG. **2**), the protruding portion **20** does not form any part of an outer contour line CL**1** of the head **4**. The outer contour line is namely a contour line (outline) of a silhouette.

In the present embodiment, the entirety of the protruding portion **20** is formed on the crown outer surface **12***a*. As shown in FIG. **3**, the head **4** has an outer contour line CL**2** in the plan view of the head **4**. As shown in FIG. **3**, the protruding portion **20** does not reach the outer contour line CL**2**. The protruding portion **20** does not extend to other portions than the crown outer surface **12***a*. In the plan view (FIG. **3**) of the head **4**, the entirety of the protruding portion **20** can be seen.

The plan view of the head **4** is a projection figure obtained by projecting the head in the reference state onto a plane parallel to the ground plane GP. This plan view (FIG. **3**) is also referred to as a planar view.

In the plan view of the head **4**, the protruding portion **20** may reach the outer contour line CL**2**. In other words, the protruding portion **20** may form a part of the outer contour line CL**2**. The protruding portion **20** may extend into other portions than the crown outer surface **12***a*. For example, the protruding portion **20** may extend from the crown outer surface **12***a* onto the sole outer surface **14***a*. For example, the protruding portion **20** may extend from the crown outer surface **12***a* onto the outer surface of a side portion (skirt portion). As described below, the position of the protruding portion **20** is not limited in the present disclosure.

Of the crown outer surface **12***a*, a portion in which the protruding portion **20** is not present is formed by a base surface b**1**. The base surface b**1** is a convex curved surface that is smooth and continuous. The convex curved surface is a curved surface that is convex toward the outside of the head **4**. As shown in FIG. **3**, the base surface b**1** belonging to the crown outer surface **12***a* includes the geometric center CR of the head **4** in the plan view. The geometric center CR is the geometric center of a figure indicated by the outer contour line CL**2**.

FIG. **5** shows a cross-sectional contour line of the outer surface of the head **4** in a cross-sectional view taken along line A-A in FIG. **3**. FIG. **6** shows a cross-sectional contour line of the outer surface of the head **4** in a cross-sectional view taken along line B-B in FIG. **3**. FIG. **7** shows a cross-sectional contour line of the outer surface of the head **4** in a cross-sectional view taken along line C-C in FIG. **3**. FIG. **8** shows a cross-sectional contour line of the outer surface of the head **4** in a cross-sectional view taken along line D-D in FIG. **3**. Each of FIG. **5** to FIG. **8** includes a cross-sectional contour line of the crown outer surface **12***a*. In the present disclosure, a cross-sectional contour line of the outer surface of the head **4** is also simply referred to as a cross-sectional contour line.

The protruding portion **20** includes a contour line CL**20**, an upper surface **22**, and a sidewall surface **24**. The contour line CL**20** is a boundary line between the base surface b**1** and the protruding portion **20**. In the plan view of the head **4** (FIG. **3**), the contour line CL**20** of the protruding portion **20** has a substantially quadrilateral shape (substantially trapezoidal shape). In the present disclosure, the word "substantially" means that a shape in question may have a curved side(s) (not straight side(s)) and/or a rounded corner(s). In the contour line CL**20** in the plan view of the head (FIG. **3**), the radius of curvature of the curved side(s) is preferably greater than or equal to 25 mm, more preferably greater than or equal to 40 mm, and still more preferably greater than or equal to 50 mm. In the contour line CL**20** in the plan view of the head (FIG. **3**), the radius of curvature of the rounded corner(s) is preferably less than or equal to 10 mm, more preferably less than or equal to 7 mm, and still more preferably less than or equal to 5 mm. The contour line CL**20** forms the substantially quadrilateral shape.

The boundary between the upper surface **22** and the sidewall surface **24** can be defined by a ridgeline. The ridgeline can be specified as a point having a radius of curvature of less than or equal to 5 mm or as a vertex of an angle in a cross-sectional contour line of the outer surface of the protruding portion **20**. Although the radius of curvature of the cross-sectional contour line can vary depending on the direction of the cross section, a cross section that has the smallest radius of curvature is selected for determining the radius of curvature to specify the ridgeline.

In the plan view (planar view) of the head **4**, the protruding portion **20** can have a substantially polygonal shape. When this substantially polygonal shape is defined as a substantially N-sided polygonal shape, N can be an integer of greater than or equal to 3. N may be an integer that is greater than or equal to 3 and less than or equal to 20.

The contour line CL**20** has a first side CL**21**, a second side CL**22**, a third side CL**23**, and a fourth side CL**24**. The first side CL**21** constitutes a side on the toe-face side of the protruding portion **20**. The first side CL**21** extends in such a manner that it goes toward the back side as it goes to the toe side. The first side CL**21** connects the second side CL**22** and the fourth side CL**24**.

The second side CL**22** constitutes a side on the heel-face side of the protruding portion **20**. The second side CL**22** extends in such a manner that it goes toward the back side as it goes to the heel side. The second side CL**22** connects the first side CL**21** and the third side CL**23**.

The third side CL**23** constitutes a side on the heel-back side of the protruding portion **20**. The third side CL**23** extends in such a manner that it goes toward the back side as it goes to the toe side. The third side CL**23** connects the second side CL**22** and the fourth side CL**24**. The third side CL**23** constitutes a curved line that projects toward the outside of the head **4**.

The fourth side CL**24** constitutes a side on the toe-back side of the protruding portion **20**. The fourth side CL**24** extends in such a manner that it goes toward the back side as it goes to the heel side. The fourth side CL**24** connects the third side CL**23** and the first side CL**21**.

The second side CL**22**, the third side CL**23**, and the fourth side CL**24** constitute a starting line of the sidewall surface **24**. That is, the second side CL**22**, the third side CL**23**, and the fourth side CL**24** constitute the boundary line between the sidewall surface **24** and the base surface b**1**. On the other hand, the first side CL**21** does not constitute a starting line of the sidewall surface **24**. The first side CL**21** constitutes the boundary line between the base surface b**1** and the upper surface **22**.

In the present disclosure, a cross-sectional contour line in a cross section taken along the toe-heel direction is also simply referred to as a t-h cross-sectional contour line. FIG. **5** shows one example of the t-h cross-sectional contour line. A t-h cross-sectional contour line of the outer surface of the head **4** is also simply referred to as a t-h cross-sectional contour line. In the present disclosure, a cross-sectional contour line in a cross section taken along the face-back direction is also simply referred to as an f-b cross-sectional contour line. FIG. **7** shows one example of the f-b cross-sectional contour line. An f-b cross-sectional contour line of the outer surface of the head **4** is also simply referred to as an f-b cross-sectional contour line.

An inflection point in the t-h cross-sectional contour line can be a point that forms the contour line CL**20**. In other words, this inflection point can be a starting point of the protruding portion **20**. The t-h cross-sectional contour line of the base surface b**1** is a curved line that projects toward the outside of the head **4**. The inflection point is a point at which the curved line that projects toward the outside of the head **4** changes into a curved line that projects toward the inside of the head **4**.

A vertex of an angle in the t-h cross-sectional contour line can be a point that forms the contour line CL**20**. In other words, this vertex can be a starting point of the protruding portion **20**. The t-h cross-sectional contour line of the base surface b**1** is a curved line that projects toward the outside of the head **4**. A line that is connected to this curved line, makes an angle, and extends toward the outside of the head **4** forms a vertex. This vertex points toward the inside of the head **4**. This vertex can be a starting point of the protruding portion **20**.

An inflection point in the f-b cross-sectional contour line can be a point that forms the contour line CL**20**. In other words, this inflection point can be a starting point of the protruding portion **20**. The f-b cross-sectional contour line of the base surface b**1** is a curved line that projects toward the outside of the head **4**. The inflection point is a point at which the curved line that projects toward the outside of the head **4** changes into a curved line that projects toward the inside of the head **4**.

A vertex of an angle in the f-b cross-sectional contour line can be a point that forms the contour line CL**20**. In other words, this vertex can be a starting point of the protruding portion **20**. The f-b cross-sectional contour line of the base surface b**1** is a curved line that projects toward the outside of the head **4**. A line that is connected to this curved line, makes an angle, and extends toward the outside of the head **4** forms a vertex. This vertex points toward the inside of the head **4**. This vertex can be a starting point of the protruding portion **20**.

Typically, the contour line CL**20** can be determined by the inflection points or the vertices. For determining the contour line CL**20**, the t-h cross-sectional contour line may be selected in preference to the f-b cross-sectional contour line. In this case, the t-h cross-sectional contour line is used for specifying the inflection point or the vertex. When it is difficult to specify the inflection point or the vertex by using the t-h cross-sectional contour line, the f-b cross-sectional contour line can be used. When the contour line of the protruding portion **20** can be visually and clearly recognized, the contour line can be determined as the contour line CL**20**.

The protruding portion **20** is a portion that protrudes relative to the base surface b**1**. A virtually extended surface b**2** that is obtained by extending the base surface b**1** can be specified on the lower side of the protruding portion **20**. The protruding portion **20** is a portion that protrudes relative to the virtually extended surface b**2**. The virtually extended surface b**2** can be considered, if no protruding portion **20** is present, as a part of the base surface b**1** formed in a region where any protruding portion **20** would be installed. The virtually extended surface b**2** is formed so as to be continuous with the base surface b**1**. The virtually extended surface b**2** is a curved surface that is convex toward the outside of the head **4**. The virtually extended surface b**2** is smoothly connected to the base surface b**1**.

FIG. **9** is an enlarged view of a portion that is surrounded by a tetragon Q**1** in FIG. **5**. FIG. **10** is an enlarged view of a portion that is surrounded by a tetragon Q**2** in FIG. **7**.

FIG. **9** shows the t-h cross-sectional contour line with a virtually extended line b**3** that can form the virtually extended surface b**2**. The virtually extended line b**3** is a curved line that projects toward the outside of the head **4**. The virtually extended line b**3** is smoothly connected to the t-h cross-sectional contour line of the base surface b**1**. The virtually extended surface b**2** can be formed by a set of virtually extended lines b**3**.

The virtually extended line b**3** smoothly connects one side end of the t-h cross-sectional contour line of the protruding portion **20** and the other side end of the t-h cross-sectional contour line of the protruding portion **20**. The virtually extended line b**3** can be drawn as a Bezier curve. A quadratic Bezier curve and a cubic Bezier curve are known as the Bezier curve. In the quadratic Bezier curve, the number of control points is one (excluding a starting point and an end point). In the cubic Bezier curve, the number of control points is two (excluding a starting point and an end point). The cubic Bezier curve is preferably used. Bezier curves drawn in FIG. **9** and FIG. **10** are cubic Bezier curves.

As shown in FIG. **9**, the t-h cross-sectional contour line has a first starting point P**1** and a second starting point P**2**. The first starting point P**1** and the second starting point P**2** are located on the contour line CL**20**.

Points P**11** and P**12** that are located on the opposite side of the first starting point P**1** from the protruding portion **20** are plotted in order to define an effective tangent line to the t-h cross-sectional contour line at the first starting point P**1**. The point P**11** is a point located 0.5 mm apart from the first starting point P**1**. The point P**12** is a point located 0.5 mm apart from the point P**11**. These distances of "0.5 mm" for these points are route lengths measured along the t-h cross-sectional contour line. The points P**11** and P**12** are located on the t-h cross-sectional contour line. A tangent line L**1** at the point P**1** to a circle that passes through these three points P**1**, P**11** and P**12** is determined. When the points P**1**, P**11** and P**12** are positioned on a single straight line, this straight line can be determined as the tangent line L**1**.

Similarly, points P**21** and P**22** that are located on the opposite side of the second starting point P**2** from the protruding portion **20** are plotted in order to define an effective tangent line to the t-h cross-sectional contour line at the second starting point P**2**. The point P**21** is a point located 0.5 mm apart from the second starting point P**2**. The point P**22** is a point located 0.5 mm apart from the point P**21**. These distances of "0.5 mm" for these points are route lengths measured along the t-h cross-sectional contour line. The points P**21** and P**22** are located on the t-h cross-sectional contour line. A tangent line L**2** at the point P**2** to a circle that passes through these three points P**2**, P**21** and P**22** is determined. When the points P**2**, P**21** and P**22** are positioned on a single straight line, this straight line can be determined as the tangent line L**2**.

When the tangent line L**1** and the tangent line L**2** are determined, then an intersection point Px between the tangent line L**1** and the tangent line L**2** is specified. Furthermore, a middle point M**1** between the point P**1** and the point Px is specified, and a middle point M**2** between the point P**2** and the point Px is specified.

A Bezier curve can be drawn by using the point P**1** as the starting point, the middle point M**1** as the first control point, the middle point M**2** as the second control point, and the point P**2** as the end point. In FIG. **9**, a Bezier curve drawn in this manner is the virtually extended line b**3**. Because of having two control points, this Bezier curve is a cubic Bezier curve.

The virtually extended line b**3** can be defined at any position in the face-back direction. The virtually extended surface b**2** can be defined as the set of these virtually extended lines b**3**.

A similar Bezier curve can be defined in the f-b cross-sectional contour line. As shown in FIG. **10**, the f-b cross-sectional contour line has a first starting point P**1** and a second starting point P**2**. The first starting point P**1** and the second starting point P**2** are located on the contour line CL**20**.

Points P**11** and P**12** that are located on the opposite side of the first starting point P**1** from the protruding portion **20** are plotted in order to define an effective tangent line to the f-b cross-sectional contour line at the first starting point P**1**. The point P**11** is a point located 0.5 mm apart from the first starting point P**1**. The point P**12** is a point located 0.5 mm apart from the point P**11**. These distances of "0.5 mm" for these points are route lengths measured along the f-b cross-sectional contour line. The points P**11** and P**12** are located on the f-b cross-sectional contour line. A tangent line L**1** at the point P**1** to a circle that passes through these three points P**1**, P**11** and P**12** is determined. When the points P**1**, P**11** and P**12** are positioned on a single straight line, this straight line can be determined as the tangent line L**1**.

Similarly, points P**21** and P**22** that are located on the opposite side of the second starting point P**2** from the protruding portion **20** are plotted in order to define an effective tangent line to the f-b cross-sectional contour line at the second starting point P**2**. The point P**21** is a point located 0.5 mm apart from the second starting point P**2**. The point P**22** is a point located 0.5 mm apart from the point P**21**. These distances of "0.5 mm" for these points are route lengths measured along the f-b cross-sectional contour line. The points P**21** and P**22** are located on the f-b cross-sectional contour line. A tangent line L**2** at the point P**2** to a circle that passes through these three points P**2**, P**21** and P**22** is determined. When the points P**2**, P**21** and P**22** are positioned on a single straight line, this straight line can be determined as the tangent line L**2**.

When the tangent line L**1** and the tangent line L**2** are determined, then an intersection point Px between the tangent line L**1** and the tangent line L**2** is specified. Furthermore, a middle point M**1** between the point P**1** and the point Px is specified, and a middle point M**2** between the point P**2** and the point Px is specified.

A Bezier curve can be drawn by using the point P**1** as the starting point, the middle point M**1** as the first control point, the middle point M**2** as the second control point, and the point P**2** as the end point. In FIG. **10**, a Bezier curve drawn in this manner is a virtually extended line b**4**.

The virtually extended line b**4** can be defined at any position in the toe-heel direction. The virtually extended surface b**2** can be defined as the set of these virtually extended lines b**4**.

In some cases, the protruding portion may reach an outer peripheral edge (outer contour line CL**4**) of the crown portion. In such a case, the number of the starting point(s) of the protruding portion which is/are formed on the boundary between the protruding portion and the base surface b**1** can be only one in the t-h cross-sectional contour line and/or the f-b cross-sectional contour line. When only one starting point is present as in this case, a circular arc that is drawn so as to path through the starting point and have a radius of curvature at the starting point can be the virtually extended line b3. That is, in this case, the virtually extended line b3 can be a circle that passes through the following three points: a first point that is the starting point; a second point located 0.5 mm apart from the first point; and a third point located 0.5 mm apart from the second point.

For determining the virtually extended surface b2, the t-h cross-sectional contour line may be used in preference to the f-b cross-sectional contour line. The virtually extended surface b2 can be determined as a set of the virtually extended lines b3 obtained from the t-h cross-sectional contour lines. When the virtually extended surface b2 is not clearly determined by the set of the virtually extended lines b3, the virtually extended surface b2 may be determined as a set of the virtually extended lines b4 obtained from the f-b cross-sectional contour lines.

A height Ht of the protruding portion **20** can be defined as a height from the virtually extended surface b2. As shown in FIG. **9**, a normal line LN that is normal to the virtually extended surface b2 at a certain point f1 has an intersection point f2 at which the normal line LN intersects the outer surface of the protruding portion **20**. A distance between the point f1 and the intersection point f2 can be defined as the height Ht of the protruding portion **20** at the intersection point f2. If the protruding portion does not intersect the normal line LN of the virtually extended surface b2 and has a point at which the protruding portion intersects a normal line that is normal to the base surface b1, the height Ht of the protruding portion at the point is defined as a height from the base surface b1. Also in this case, the length of the normal line is the height Ht.

[0-degree state, θ-degree state, projection direction]

In the present disclosure, a 0-degree state, and a θ-degree state that encompasses this 0-degree state are defined. In addition, a projection direction is defined.

FIG. **11**A and FIG. **11**B show the head **4** in the 0-degree state. The viewing direction of FIG. **11**A and that of FIG. **11**B are different by 90°. For easier comparison between FIG. **11**A and FIG. **11**B, three axes (x-axis, y-axis, z-axis) of a three-dimensional orthogonal coordinate system are added to these drawings.

A state of a head placed in such a manner that the shaft axis line Z is vertical to a horizontal plane hp and the normal line Lf of the striking face **10***a* is parallel to a first perpendicular plane V1 on which the shaft axis line Z lies is defined as a 0-degree state.

The first perpendicular plane V1 is perpendicular to the horizontal plane hp. In FIG. **11**A, the first perpendicular plane V1 is shown as a straight line that coincides with the shaft axis line Z. In FIG. **11**B, the first perpendicular plane V1 is a plane parallel to the drawing sheet of this figure.

A direction that is parallel to the first perpendicular plane V1 and is parallel to the horizontal plane hp is defined as a projection direction PD1. The projection direction PD1 is perpendicular to the shaft axis line Z.

The projection direction PD1 is specified in one direction. As is described below, the head **4** is rotated by θ° about the shaft axis line Z, but even with the rotation of the head **4**, the first perpendicular plane V1 does not rotate, to make the projection direction PD1 unchanged.

FIG. **12** is a projection figure obtained by projecting the head **4** in the 0-degree state in the projection direction PD1. This projection figure is shown in silhouette. As is described below, the silhouette has an area that is denoted by WA0.

Unless otherwise noted, a projection figure in the present disclosure is a projection figure obtained by projecting an object in the projection direction PD1. This projection figure is a parallel projection figure obtained by projecting an object with light rays parallel to the projection direction PD1.

In the present disclosure, a state in which the head **4** in the 0-degree state is rotated by θ° about the shaft axis line Z toward the back side is defined as a θ-degree state. For example, a state in which the head **4** in the 0-degree state is rotated by 15° about the shaft axis line Z toward the back side is defined as a 15-degree state. For example, a state in which the head **4** in the 0-degree state is rotated by 30° about the shaft axis line Z toward the back side is defined as a 30-degree state. For example, a state in which the head **4** in the 0-degree state is rotated by 90° about the shaft axis line Z toward the back side is defined as a 90-degree state.

The angle θ is set to be greater than or equal to 0° and less than or equal to 90°. This range of θ corresponds to the motion of the head **4** from the start of face rotation to the impact in downswing.

FIG. **13**A shows the head **4** in the 0-degree state. FIG. **14**A shows the head **4** in the 15-degree state. FIG. **15**A shows the head **4** in the 90-degree state. In FIG. **13**A, FIG. **14**A, and FIG. **15**A, the projection direction PD1 is a direction perpendicular to the drawing sheets of these figures. As shown in these drawings, regarding the head **4** in the θ-degree state, the posture of the head **4** with respect to the projection direction PD1 changes with the angle θ.

The θ-degree state reflects the relationship between the posture of the head **4** and the moving direction of the head **4** during downswing. The projection direction PD1 corresponds to the moving direction of the head **4** during downswing. In other words, the projection direction PD1 corresponds to the direction of air flow hitting the head **4** during downswing. In the projection direction PD1, the sense of the vector of movement of the head and the sense of the vector of the air flow are opposite to each other. In the drawings of the present disclosure, the projection direction PD1 is indicated by the sense of the vector of the air flow. Note that in the expressions of "the projection direction", "the moving direction of the head", "the sense of the vector of movement of the head", "the direction of the air flow", and "the sense of the vector of the air flow", the terms of "direction" and "sense of the vector" are used as different meanings. In these phrases, the terms of "direction" and "sense of a vector" are used in the mathematical meanings. More specifically, the "direction" means an expression implying two (opposite) "senses of a vector", and there are two "senses of the vector" in one "direction" along a straight line.

FIG. **16** shows the motion of the golf club **2** during downswing. A swinging motion starts from backswing, then transitions from the top of swing to downswing, and reaches impact. With the progress of the downswing, head speed is accelerated. In addition, with the progress of the downswing, the posture of the head changes.

At a certain point of time during downswing, the shaft **6** of the golf club **2** is made parallel to the ground surface. The position of the golf club **2** at this point of time is also referred to as position **9**. A position of the golf club at impact is also referred to as position **6**. These positions are named by considering the golf club **2** during swing as an hour hand of a clock. That is, for example, the position **9** coincides with the position of an hour hand at nine o'clock in a clock with hands (analog clock).

Wrists of a golfer turn during downswing, and the face rotation progresses. The face rotation is typically started at the position **9** or in the vicinity thereof. The face rotation allows the striking face **10***a* to be oriented toward a target direction at impact.

Given that the moving direction of the head **4** corresponds to the projection direction PD**1**, the posture of the head **4** is in the 90-degree state when the head **4** starts face rotation. Given that the moving direction of the head **4** corresponds to the projection direction PD**1**, the posture of the head **4** is in the 0-degree state when the head **4** is positioned at impact. The posture of the head **4** from the start of face rotation till impact corresponds to the θ-degree state when the angle θ is continuously changed from 90° to 0°. The angle θ decreases as the head approaches the impact position.

During downswing, the head **4** moves with its heel side ahead, and receives air resistance during this movement. The inventors of the present disclosure have found that the moving direction of the head **4** in the process of face rotation substantially corresponds to the above-described projection direction PD**1**. The θ-degree state, with θ ranging from 0 to 90, reflects changes of the posture of the head with the progress of face rotation. With the θ-degree state and the projection direction PD**1** taken into consideration, the state of the head **4** during downswing can be appropriately evaluated.

[WAθ, Afθ, Abθ, Sθ]

A projected area of the head **4** projected in the projection direction PD**1** when the head **4** is rotated by θ° about the shaft axis line Z toward the back side from the 0-degree state is denoted by WAθ (mm^2). For example, a projected area of the head **4** projected in the projection direction PD**1** when the head **4** is in the 0-degree state is denoted by WA**0** (mm^2). WA**0** represents the projected area of the head **4** in the 0-degree state. For example, a projected area of the head **4** projected in the projection direction PD**1** when the head **4** is rotated by 15° about the shaft axis line Z toward the back side from the 0-degree state is denoted by WA**15** (mm^2). WA**15** represents the projected area of the head **4** in the 15-degree state. For example, a projected area of the head **4** projected in the projection direction PD**1** when the head **4** is rotated by 30° about the shaft axis line Z toward the back side from the 0-degree state is denoted by WA**30** (mm^2). WA**30** represents the projected area of the head **4** in the 30-degree state. For example, a projected area of the head **4** projected in the projection direction PD**1** when the head **4** is rotated by 90° about the shaft axis line Z toward the back side from the 0-degree state is denoted by WA**90** (mm^2). WA**90** represents the projected area of the head **4** in the 90-degree state. WAθ is the projected area of the entirety of the head **4**.

Accordingly, for example, the silhouette in the projection figure shown in FIG. **12**, which is in the 0-degree state, has a projected area of WA**0**.

Each projection figure can be divided into a first region and a second region by the shaft axis line Z. A region to which a force acting in such a direction that the striking face is opened is applied due to air resistance during downswing is defined as the first region. A region to which a force acting in such a direction that the striking face is closed is applied due to the air resistance is defined as the second region. The first region is a region on the face side or the toe side with respect to the shaft axis line Z. The second region is a region on the back side or the heel side with respect to the shaft axis line Z.

Of the projected area WAθ, the area of its first region is denoted by Afθ (mm^2). For example, of the projected area WA**0**, the area of its first region is denoted by Af**0**. For example, of the projected area WA**15**, the area of its first region is denoted by Af**15**. For example, of the projected area WA**30**, the area of its first region is denoted by Af**30**. For example, of the projected area WA**90**, the area of its first region is denoted by Af**90**.

On the other hand, of the projected area WAθ, the area of its second region is denoted by Abθ (mm^2). For example, of the projected area WA**0**, the area of its second region is denoted by Abθ. For example, of the projected area WA**15**, the area of its second region is denoted by Ab**15**. For example, of the projected area WA**30**, the area of its second region is denoted by Ab**30**. For example, of the projected area WA**90**, the area of its second region is denoted by Ab**90**.

FIG. **13**B is a projection figure of the head **4** in the 0-degree state divided by the shaft axis line Z into two regions. FIG. **14**B is a projection figure of the head **4** in the 15-degree state divided by the shaft axis line Z into two regions. FIG. **15**B is a projection figure of the head **4** in the 90-degree state divided by the shaft axis line Z into two regions. Since the head **4** is for a right-hander, in these projection figures, the left side with respect to the shaft axis line Z is the first region, and the right side with respect to the shaft axis line Z is the second region.

For example, in the 0-degree state in FIG. **13**B, a portion indicated with broken line hatching has an area that is denoted by Af**0**, and a portion indicated with solid line hatching has an area that is denoted by Ab**0**. The sum of Af**0** and Ab**0** is WA**0**.

For example, in the 15-degree state in FIG. **14**B, a portion indicated with broken line hatching has an area that is denoted by Af**15**, and a portion indicated with solid line hatching has an area that is denoted by Ab**15**. The sum of Af**15** and Ab**15** is WA**15**.

For example, in the 90-degree state in FIG. **15**B, a portion indicated with broken line hatching has an area that is denoted by Af**90**, and a portion indicated with solid line hatching has an area that is denoted by Ab**90**. The sum of Af**90** and Ab**90** is WA**90**.

In this way, even when θ is any angle within the range of 0° to 90° inclusive, the projected area WAθ in the θ-degree state is divided into the area Afθ of the first region, and the area Abθ of the second region.

A value of Afθ minus Abθ, that is, a difference (Afθ−Abθ) is denoted by Sθ (mm^2). For example, a difference (Af**0**−Ab**0**) is denoted by S**0**. For example, a difference (Af**15**−Ab**15**) is denoted by S**15**. For example, a difference (Af**30**−Ab**30**) is denoted by S**30**. For example, a difference (Af**90**−Ab**90**) is denoted by S**90**.

During swing, air resistance acts on the head **4**. This air resistance can act as a force that causes the head **4** to rotate about the shaft axis line Z. The influence of this air resistance on the head **4** varies depending on the projected area of the head **4** projected in the projection direction corresponding to the sense of the vector of the air flow.

The air resistance received by the first region rotates the head **4** in such a direction that the face **10***a* is opened. Accordingly, the greater the area Afθ is, the more easily the face **10***a* is opened. On the other hand, the air resistance received by the second region rotates the head **4** in such a direction that the face **10***a* is closed. Accordingly, the greater the area Abθ is, the more easily the face **10***a* is closed. In addition, as the area Abθ becomes greater with respect to the area Afθ, the face **10***a* is more easily closed.

The head **4** is designed so that the second region has a large area when the head **4** is positioned at the start of face rotation. That is, the head **4** is designed so that Ab**90** is large. This increases the air resistance acting on the second region, thereby allowing a force to easily act in such a direction that the face **10***a* is closed. In the 90-degree state, the area Ab**90** of the second region is large (see FIG. 15B), and by utilizing such a large Ab**90**, the face rotation is promoted. In addition, the head **4** is designed so that the first region has a small area when the head **4** is positioned immediately before impact. That is, the head **4** is designed so that Af**15** is small. This decreases the air resistance acting on the first region, thereby facilitating the face rotation. Further, by decreasing Af**15** of the first region, which occupies a large proportion in the projected area WA**15** when the head **4** is positioned immediately before impact, the air resistance acting on the head as a whole is suppressed, whereby head speed can be increased. As the head speed is high immediately before impact, the air resistance is likely to increase. Accordingly, by decreasing Af**15**, the air resistance acting on the head **4** can be suppressed effectively.

The promotion of face rotation leads to excellent ball catchability. Such excellent ball catchability can prevent an impact in a state in which the face **10***a* is opened, which can increase the flight distance. In addition, the increase in the head speed leads to an increase in the flight distance.

The "excellent ball catchability" means that the face **10***a* is unlikely to be open at impact. When a head having excellent ball catchability is used, the face **10***a* is likely to be square or slightly closed at impact. When a head having excellent ball catchability is used, the energy of the head is efficiently transmitted to a ball, which can produce a strong trajectory of the hit ball and increase the flight distance.

With a view to promoting the face rotation and increasing the head speed, S**90** (mm^2), which is the difference (Af**90**−Ab**90**), is preferably small. From this viewpoint, S**90** is preferably less than or equal to −4500 (mm^2), more preferably less than or equal to −4550 (mm^2), still more preferably less than or equal to −4600 (mm^2), and even more preferably less than or equal to −4700 (mm^2). Considering a restriction in head volume, S**90** is preferably greater than or equal to −5100 (mm^2), more preferably greater than or equal to −5000 (mm^2), and further preferably greater than or equal to −4900 (mm^2).

With a view to promoting the face rotation and increasing the head speed, S**15** (mm^2), which is the difference (Af**15**−Ab**15**), is preferably small. From this viewpoint, S**15** is preferably less than or equal to 4700 (mm^2), more preferably less than or equal to 4650 (mm^2), still more preferably less than or equal to 4600 (mm^2), even more preferably less than or equal to 4550 (mm^2), and further more preferably less than or equal to 4500 (mm^2). With a view to increasing the moment of inertia of the head **4** and enlarging a sweet area, the head **4** preferably has a large head volume. From this viewpoint, S**15** is preferably greater than or equal to 4200 (mm^2), more preferably greater than or equal to 4300 (mm^2), and still more preferably greater than or equal to 4400 (mm^2).

The head can be designed so that the second region has a large projected area while the projected area of the entirety of the head is suppressed, when the head is positioned at the start of face rotation. An increase in the air resistance acting on the second region allows the face **10***a* to be easily closed. From these viewpoints, a ratio (WA**90**/Ab**90**) is preferably less than or equal to 1.205, more preferably less than or equal to 1.200, and still more preferably less than or equal to 1.195. A head having Ab**90** excessively large with respect to Af**90** could cause golfers to feel a sense of incongruity in the shape of the head. From this viewpoint, the ratio (WA**90**/Ab**90**) is preferably greater than or equal to 1.100, more preferably greater than or equal to 1.130, and still more preferably greater than or equal to 1.160.

The head can be designed so that the second region has a large projected area, while the projected area of the entirety of the head is suppressed, when the head is positioned immediately before impact. This reduces air resistance acting on the head as a whole, which can increase the head speed. In addition, this increases air resistance acting on the second region, which allows the face **10***a* to be easily closed and promotes the face rotation. From these viewpoints, a ratio (WA**15**/Ab**15**) is preferably less than or equal to 7.00, more preferably less than or equal to 6.80, and still more preferably less than or equal to 6.50. A head having Ab**15** excessively small with respect to Af**15** could cause golfers to feel a sense of incongruity in the shape of the head. From this viewpoint, the ratio (WA**15**/Ab**15**) is preferably greater than or equal to 5.50, more preferably greater than or equal to 5.80, and still more preferably greater than or equal to 6.00.

Increasing an absolute value of S**90** at the start of face rotation enables to increase a force acting in such a direction that the face **10***a* is closed. In addition, decreasing an absolute value of S**15** immediately before impact enables to decrease a force acting in such a direction that the face **10***a* is opened, and to reduce air resistance. With a view to promoting the face rotation and increasing the head speed, a ratio (|S**90**|/|S**15**|) is preferably greater than or equal to 1.00, more preferably greater than or equal to 1.06, still more preferably greater than or equal to 1.10, and further preferably greater than or equal to 1.12. From the viewpoint of the sense of incongruity in the shape of the head, the ratio (|S**90**|/|S**15**|) is preferably less than or equal to 1.20, more preferably less than or equal to 1.18, and still more preferably less than or equal to 1.16.

Note that "|S**90**|" means the absolute value of S**90**, and "|S**15**|" means the absolute value of S**15**. In the present embodiment, since S**90** is a negative value, |S**90**| is equal to −S**90**. On the other hand, since S**15** is a positive value, |S**15**| is equal to S**15**.

As shown in FIG. **15**A, the protruding portion **20** is viewable in the projection figure of the head **4** in the 90-degree state. The protruding portion **20** constitutes a part of the outer contour line in the projection figure of the head **4** in the 90-degree state. The protruding portion **20** affects Ab**90**. The protruding portion **20** increases Ab**90**. On the other hand, as shown in FIG. **13**A, the protruding portion **20** is not viewable in the projection figure of the head **4** in the 0-degree state. The protruding portion **20** does not constitute any part of the outer contour line in the projection figure of the head **4** in the 0-degree state. The protruding portion **20** does not affect Af**0**. The protruding portion **20** does not increase Af**0**. The protruding portion **20** does not increase Ab**0**. As shown in FIG. **14**A, the protruding portion **20** is not viewable in the projection figure of the head **4** in the 15-degree state. The protruding portion **20** does not constitute any part of the outer contour line in the projection figure of the head **4** in the 15-degree state. The protruding portion **20** does not affect Af**15**. The protruding portion **20** does not increase Af**15**. The protruding portion **20** does not increase Ab**15**. The protruding portion **20** contributes to decreasing S**90** and not increasing S**15**. The protruding portion **20** contributes to decreasing the ratio (WA**90**/Ab**90**) and not increasing the ratio (WA**15**/Ab**15**). The protruding portion **20** contributes to increasing the ratio (|S**90**|/|S**15**|).

FIG. **17**A shows a silhouette of the projection figure of the head **4** in the 90-degree state. In this projection figure, the contour line of the head **4** includes a protuberance **30**. This protuberance **30** is also referred to as a silhouette protuberance. As described above, the protruding portion **20** can be seen in the projection figure of the head **4** in the 90-degree state. The silhouette protuberance **30** is formed by the protruding portion **20**. Ab**90** is enlarged by the presence of the silhouette protuberance **30**.

An inflection point of the contour line of the projection figure of the head **4** can be a starting point of the silhouette protuberance **30**. A vertex of an angle of the contour line of the projection figure of the head **4** can be a starting point of the silhouette protuberance **30**. In the present embodiment, not an inflection point but a vertex is the starting point of the silhouette protuberance **30** on each side of the silhouette protuberance **30**. As shown in FIG. **17**B, in the silhouette protuberance **30** of the present embodiment, vertices P**31** and P**32** of angles are the starting points of the silhouette protuberance **30**.

A cubic Bezier curve can be drawn also for the silhouette protuberance **30** in the same manner as discussed above. A two-dot chain line in FIG. **17**B shows the Bezier curve. This Bezier curve is a curved line that smoothly connects curved lines adjacent to both ends of the silhouette protuberance **30**. This Bezier curve can be a contour line **30***a* of the projection figure when the protruding portion **20** is not present. An area of a portion surrounded by the line of the silhouette protuberance **30** and the virtual contour line **30***a* is indicated with hatching. This area is an area added by the protruding portion **20**. This area is also referred to as an additional area. The protruding portion **20** increases WA**90** by this additional area. The protruding portion **20** increases Ab**90** by this additional area.

With a view to increasing the additional area in Ab**90** in the 90-degree state to increase air resistance on the second region, the maximum value of the height Ht of the protruding portion **20** is preferably greater than or equal to 2 mm, more preferably greater than or equal to 2.5 mm, and still more preferably greater than or equal to 3 mm. An excessively large height Ht produces the additional area in Af**15** of the 15-degree state and increases air resistance on the first region. From this viewpoint, the maximum value of the height Ht of the protruding portion **20** is preferably less than or equal to 12 mm, more preferably less than or equal to 10 mm, and still more preferably less than or equal to 8 mm.

Note that even when the protruding portion forms a part of the contour line of the projection figure, the silhouette protuberance is not formed in the projection figure in some cases. For example, when the protruding portion reaches the outer peripheral edge of the crown portion and extends along the outer peripheral edge, the silhouette protuberance might not be formed. Even in such a case, however, the protruding portion increases the projected area WAθ in the projection figure.

FIG. **18** is a plan view of a head **104** according to a second embodiment. FIG. **19** is a perspective view of the head **104**, with its sole **114** faced upward, as viewed from the back toe side. FIG. **20**A shows the head **104** in the 0-degree state. FIG. **21**A shows the head **104** in the 15-degree state. FIG. **22**A shows the head **104** in the 90-degree state. In FIG. **20**A, FIG. **21**A, and FIG. **22**A, the projection direction PD1 is a direction perpendicular to the drawing sheets of these figures.

FIG. **20**B is a projection figure of the head **104** in the 0-degree state divided by the shaft axis line Z into two regions. FIG. **21**B is a projection figure of the head **104** in the 15-degree state divided by the shaft axis line Z into two regions. FIG. **22**B is a projection figure of the head **104** in the 90-degree state divided by the shaft axis line Z into two regions.

The head **104** includes a face portion **110**, a crown portion **112**, a sole portion **114**, and a hosel portion **116**. The face portion **110** includes a striking face **110***a*. The striking face **110***a* is the outer surface of the face portion **110**. The crown portion **112** forms a crown outer surface **112***a*. The sole portion **114** forms a sole outer surface **114***a*. The hosel portion **116** has a shaft hole **116***a*.

The striking face **110***a* has a face center Fc as defined above. The striking face **110***a* has a normal line Lf. The normal line Lf is a line normal to the striking face **110***a* at the face center Fc.

The head **104** includes, on its outer surface, a protruding portion **120**. In the present embodiment, the protruding portion **120** is formed on the sole portion **114**. The sole portion **114** includes the protruding portion **120** on the sole outer surface **114***a*. Although not shown in the drawings, the protruding portion **120** is hollow. The protruding portion **120** forms a projection on the sole outer surface **114***a* and forms a recess on a sole inner surface. The protruding portion **120** may be solid (not hollow). The protruding portion **120** is positioned on the back side in the sole portion **114**. The protruding portion **120** is positioned on the back side with respect to the center of gravity of the head **104**.

In the present embodiment, the entirety of the protruding portion **120** is formed on the sole outer surface **114***a*. The protruding portion **120** does not extend to other portions than the sole outer surface **114***a*.

In the 0-degree state shown in FIG. **20**B, a portion indicated with broken line hatching has an area that is denoted by Afθ, and a portion indicated with solid line hatching has an area that is denoted by Ab**0**. The sum of Af**0** and Ab**0** is WA**0**.

In the 15-degree state shown in FIG. **21**B, a portion indicated with broken line hatching has an area that is denoted by Af**15**, and a portion indicated with solid line hatching has an area that is denoted by Ab**15**. The sum of Af**15** and Ab**15** is WA**15**.

In the 90-degree state shown in FIG. **22**B, a portion indicated with broken line hatching has an area that is denoted by Af**90**, and a portion indicated with solid line hatching has an area that is denoted by Ab**90**. The sum of Af**90** and Ab**90** is WA**90**.

As shown in FIG. **22**A, the protruding portion **120** is viewable in the projection figure of the head **104** in the 90-degree state. As shown in FIG. **22**B, the protruding portion **120** constitutes a part of the outer contour line in the projection figure of the head **104** in the 90-degree state. The protruding portion **120** affects Ab**90**. The protruding portion **120** increases Ab**90**. The protruding portion **120** does not increase Af**90**. As shown in FIG. **20**A, the protruding portion **120** is viewable in the projection figure of the head **104** in the 0-degree state. As shown in FIG. **20**B, the protruding portion **120** constitutes a part of the outer contour line in the projection figure of the head **104** in the 0-degree state. The protruding portion **120**, however, has a small effect on Af**0**. The protruding portion **120** hardly increases Af**0**. The protruding portion **120** does not increase Ab**0**. As shown in FIG. **21**A, the protruding portion **120** is not viewable in the projection figure of the head **104** in the 15-degree state. As shown in FIG. **21**B, the protruding portion **120** does not constitute any part of the outer contour line in the projection figure of the head **104** in the 15-degree state. The protruding portion **120** does not affect Af**15**. The protruding portion **120** does not increase Af**15**. The protruding portion **120** does not increase Ab**15**. The protruding portion **120** contributes to decreasing S**90** and not increasing S**15**. The protruding portion **120** contributes to decreasing the ratio (WA**90**/

Ab**90**) and not increasing the ratio (WA**15**/Ab**15**). The protruding portion **120** contributes to increasing the ratio (|S**90**|/|S**15**|).

As shown in FIG. **22**B, the projection figure of the head **104** in the 90-degree state includes a silhouette protuberance **130**. As described above, the protruding portion **120** can be seen in the projection figure of the 90-degree state. The silhouette protuberance **130** is formed by the protruding portion **120**. Ab**90** is enlarged by the presence of the silhouette protuberance **130**.

As shown in FIG. **20**B, the projection figure of the head **104** in the 0-degree state includes a silhouette protuberance **132**. The silhouette protuberance **132** is formed by the protruding portion **120**. Af**0** is enlarged by the presence of the silhouette protuberance **132**. The additional area added by the presence of the silhouette protuberance **132**, however, is small.

In the 90-degree state, the protruding portion **120** forms an additional area in the second region, and does not form an additional area in the first region (see FIG. **22**A and FIG. **22**B). In the 15-degree state, the protruding portion **120** does not form an additional area in the first region, and does not form an additional area in the second region (see FIG. **21**A and FIG. **21**B). In the 0-degree state, the protruding portion **120** hardly forms an additional area in the first region, and does not form an additional area in the second region (see FIG. **20**A and FIG. **20**B). The additional area in the second region of the 90-degree state is denoted by D**90**. The additional area in the first region of the 15-degree state is denoted by M**15**. The additional area in the first region of the 0-degree state is denoted by M**0**. As described above, M**0** is small in the head **104**. From the viewpoint of the face rotation, M**0**/D**90** is preferably less than or equal to 0.3, more preferably less than or equal to 0.2, still more preferably less than or equal to 0.1, and even more preferably 0. M**15**/D**90** is preferably less than or equal to 0.3, more preferably less than or equal to 0.2, still more preferably less than or equal to 0.1, and even more preferably 0. In the head **104**, the additional area M**15** is zero.

FIG. **23** is a plan view of a head **204** according to a third embodiment. FIG. **24** is a perspective view of the head **204**, with its sole **214** faced upward, as viewed from the heel back side. FIG. **25**A shows the head **204** in the 0-degree state. FIG. **26**A shows the head **204** in the 15-degree state. FIG. **27**A shows the head **204** in the 90-degree state. In FIG. **25**A, FIG. **26**A, and FIG. **27**A, the projection direction PD**1** is a direction perpendicular to the drawing sheets of these figures.

FIG. **25**B is a projection figure of the head **204** in the 0-degree state divided by the shaft axis line Z into two regions. FIG. **26**B is a projection figure of the head **204** in the 15-degree state divided by the shaft axis line Z into two regions. FIG. **27**B is a projection figure of the head **204** in the 90-degree state divided by the shaft axis line Z into two regions.

The head **204** includes a face portion **210**, a crown portion **212**, a sole portion **214**, and a hosel portion **216**. The face portion **210** includes a striking face **210***a*. The striking face **210***a* is the outer surface of the face portion **210**. The crown portion **212** forms a crown outer surface **212***a*. The sole portion **214** forms a sole outer surface **214***a*. The hosel portion **216** has a shaft hole **216***a*.

The striking face **210***a* has a face center Fc as defined above. The striking face **210***a* has a normal line Lf. The normal line Lf is a line normal to the striking face **210***a* at the face center Fc.

The head **204** includes, on its outer surface, a protruding portion **220**. In the present embodiment, the protruding portion **220** is formed on the sole portion **214**. The sole portion **214** includes the protruding portion **220** on the sole outer surface **214***a*. Although not shown in the drawings, the protruding portion **220** is hollow. The protruding portion **220** forms a projection on the sole outer surface **214***a* and forms a recess on a sole inner surface. The protruding portion **220** may be solid (not hollow).

The protruding portion **220** is positioned on the heel side in the sole portion **214**. The protruding portion **220** is positioned on the heel side with respect to the center of gravity of the head **204**. The protruding portion **220** is positioned on the heel side with respect to the shaft axis line Z. The head **204** does not include a skirt portion (side portion). The sole outer surface **214***a* of the head **204** extends to an outer edge of the crown outer surface **212***a*. When the head includes a skirt portion between the crown portion **212** and the sole portion **214**, the protruding portion **220** may be provided on the skirt portion.

In the 0-degree state shown in FIG. **25**B, a portion indicated with broken line hatching has an area that is denoted by Af**0**, and a portion indicated with solid line hatching has an area that is denoted by Ab**0**. The sum of Af**0** and Ab**0** is WA**0**.

In the 15-degree state shown in FIG. **26**B, a portion indicated with broken line hatching has an area that is denoted by Af**15**, and a portion indicated with solid line hatching has an area that is denoted by Ab**15**. The sum of Af**15** and Ab**15** is WA**15**.

In the 90-degree state shown in FIG. **27**B, a portion indicated with broken line hatching has an area that is denoted by Af**90**, and a portion indicated with solid line hatching has an area that is denoted by Ab**90**. The sum of Af**90** and Ab**90** is WA**90**.

As shown in FIG. **27**A, the protruding portion **220** is viewable in the projection figure of the head **204** in the 90-degree state. As shown in FIG. **27**B, however, the protruding portion **220** does not constitute any part of the outer contour line in the projection figure of the 90-degree state. The protruding portion **220** does not affect Ab**90**. The protruding portion **220** does not increase Ab**90**. The protruding portion **220** does not affect Af**90**. The protruding portion **220** does not increase Af**90**. As shown in FIG. **25**A, the protruding portion **220** is viewable in the projection figure of the head **204** in the 0-degree state. As shown in FIG. **25**B, the protruding portion **220** constitutes a part of the outer contour line in the projection figure of the 0-degree state. The protruding portion **220** increases Ab**0**. On the other hand, the protruding portion **220** does not increase Af**0**. As shown in FIG. **26**A, the protruding portion **220** is viewable in the projection figure of the head **204** in the 15-degree state. As shown in FIG. **26**B, the protruding portion **220** constitutes a part of the outer contour line in the projection figure of the 15-degree state. The protruding portion **220** increases Ab**15**. On the other hand, the protruding portion **220** does not affect Af**15**. The protruding portion **220** does not increase Af**15**. The protruding portion **220** contributes to decreasing S**15** without increasing S**90**. The protruding portion **220** contributes to decreasing the ratio (WA**15**/Ab**15**) without increasing the ratio (WA**90**/Ab**90**). The protruding portion **220** contributes to increasing the ratio (|S**90**|/|S**15**|).

As shown in FIG. **26**B, in the projection figure of the 15-degree state, the contour line of the head **204** includes a silhouette protuberance **230**. The silhouette protuberance **230** is formed by the protruding portion **220**. Ab**15** is enlarged by the presence of the silhouette protuberance **230**. In the projection figure of the head **204** in the 15-degree state, Ab**15** includes an additional area added by the presence of the protruding portion **220**.

As shown in FIG. **25**B, in the projection figure of the 0-degree state, the contour line of the head **204** includes a silhouette protuberance **232**. The silhouette protuberance **232** is formed by the protruding portion **220**. Ab**0** is enlarged by the presence of the silhouette protuberance **232**. In the projection figure of the 0-degree state, Ab**0** includes an additional area added by the presence of the protruding portion **220**. The additional area in the 0-degree state is greater than that in the 15-degree state.

In the 90-degree state, the protruding portion **220** does not form an additional area in the second region, and does not form an additional area in the first region (see FIG. **27**A and FIG. **27**B). In the 15-degree state, the protruding portion **220** does not form an additional area in the first region, and forms the additional area in the second region (see FIG. **26**A and FIG. **26**B). In the 0-degree state, the protruding portion **220** does not form an additional area in the first region, and forms the additional area in the second region (see FIG. **25**A and FIG. **25**B).

When the head **204** is positioned at the start of face rotation (90-degree state), Abθ is greater than Afθ. Accordingly, S**90** is a negative value. As the face rotation progresses, the angle θ continuously decreases from 90° toward 0°. As the angle θ decreases, Afθ increases and Abθ decreases. Afθ is greater than Abθ when the head **204** is positioned immediately before impact. That is, S**15** is a positive value.

While θ changes continuously from 90° to 0°, the difference (Afθ−Abθ) turns from a negative value to a positive value. Accordingly, the angle θ has a value at which Afθ is equal to Abθ, that is, at which the difference (Afθ−Abθ) is zero. In other words, the angle θ has a value at which Sθ is zero.

In a phase where Sθ is a negative value, the projected area Abθ of the second region is greater than the projected area Afθ of the first region. Since Abθ is relatively larger, the face rotation can be promoted. By prolonging the period while Sθ is a negative value during downswing, the period while the face rotation is assisted can be longer. From this viewpoint, the value of θ at which Sθ is zero is preferably less than or equal to 55°, more preferably less than or equal to 53°, still more preferably less than or equal to 52°, and further preferably less than or equal to 51°. With a view to not causing golfers to feel a sense of incongruity in the shape of the head, the value of θ at which Sθ is zero is preferably greater than or equal to 43°, more preferably greater than or equal to 45°, and still more preferably greater than or equal to 47°.

As described above, at the start of face rotation, Abθ is large, and the ratio (WAθ/Abθ) is smaller than 2.0. That is, WA**90**/Ab**90** is smaller than 2.0. As the face rotation progresses and θ decreases, Abθ decreases and Afθ increases. While θ changes continuously from 90° to 0°, Afθ becomes equal to Abθ, and WAθ/Abθ becomes 2.0. WA**15**/Ab**15** is greater than 2.0 immediately before impact. WA**0**/Ab**0** is greater than 2.0 at impact.

When WAθ/Abθ is smaller than 2.0, Abθ is greater than Afθ. By shortening the period while WAθ/Abθ is smaller than 2.0, the period while the face rotation is assisted can be longer. From this viewpoint, the value of θ at which WAθ/Abθ is 2.0 is preferably less than or equal to 55°, more preferably less than or equal to 53°, still more preferably less than or equal to 52°, and further preferably less than or equal to 51°. With a view to not causing golfers to feel a sense of incongruity in the shape of the head, the value of θ at which WAθ/Abθ is 2.0 is preferably greater than or equal to 43°, more preferably greater than or equal to 45°, and still more preferably greater than or equal to 47°.

(S**15**−S**0**)/15 represents the rate of change of Sθ with respect to θ immediately before impact (a phase where θ ranges from 0° to 15°). As the head moves from the 15-degree state (immediately before impact) toward the 0-degree state (at impact), Afθ increases, and Sθ increases. Accordingly, (S**15**−S**0**)/15 has a negative value. Immediately before impact, the head speed is being accelerated, and the influence of the air resistance acting on the head is increasing. By decreasing an absolute value of the rate of change, in the phase where θ ranges from 0° to 15°, Afθ is suppressed, and the face is easily turned. From this viewpoint, (S**15**−S**0**)/15 is preferably greater than −45, more preferably greater than −35, and still more preferably greater than −30. When the face is turned too much, a sharp hook shot can be caused (this is called "Chipin" in Japanese, or "duck hook" in English). With a view to preventing such a hook shot, (S**15**−S**0**)/15 is preferably less than or equal to −10, more preferably less than or equal to −15, and still more preferably less than or equal to −20.

(S**30**−S**15**)/15 represents the rate of change of Sθ with respect to θ before impact (a phase where θ ranges from 15° to 30°). As the head moves from the 30-degree state (before impact) toward the 15-degree state (immediately before impact), Afθ increases, and Sθ increases. Accordingly, as with (S**15**−S**0**)/15, (S**30**−S**15**)/15 has a negative value. The absolute value of the rate of change in the range of θ from 0° to 15° is made smaller than the absolute value of the rate of change in the range of θ from 15° to 30°, whereby Afθ is suppressed in the phase where θ ranges from 0° to 15° and the face is easily turned. From this viewpoint, (S**30**−S**15**)/15 is preferably smaller than (S**15**−S**0**)/15. That is, the following relational expression is preferably established:

$$SL_{0\text{-}15} > SL_{15\text{-}30},$$

where "$SL_{0\text{-}15}$" means [(S**15**−S**0**)/15] and "$SL_{15\text{-}30}$" means [(S**30**−S**15**)/15]. As described above, both of $SL_{0\text{-}15}$ and $SL_{15\text{-}30}$ have negative values, and accordingly, in comparison of their absolute values, the magnitude relationship is reversed.

A double-pointed arrow H**1** in FIG. **2** shows a head length in the toe-heel direction. In a head that is in the reference state, a plane XP that is parallel to the ground plane GP and is positioned 0.875 inches above the ground plane GP is determined. Among points on an intersection line between this plane XP and the outer surface of the head, a point that is located at a heel-most position is defined as a heel reference point Ph. This heel reference point Ph is defined as a heel-side starting point of the head length H**1**. A double-pointed arrow W**1** in FIG. **18** shows a head width in the face-back direction.

A large head has a large moment of inertia and a large sweet area, but air resistance acting thereon is large. In the present disclosure, this air resistance is utilized to increase a force acting in such a direction that the striking face is closed, thereby improving the ball catchability. From this viewpoint, a head having large dimensions is preferred.

With a view to improving the ball catchability by utilizing air resistance, and from the viewpoint of moment of inertia, the head width W**1** in the face-back direction is preferably greater than or equal to 100 mm, more preferably greater than or equal to 101 mm, and still more preferably greater than or equal to 102 mm. From the viewpoint of the rules of golf regulating a head volume, the head width W1 is preferably less than or equal to 127 mm, more preferably less than or equal to 126 mm, and still more preferably less than or equal to 125 mm.

With a view to improving the ball catchability by utilizing air resistance, and from the viewpoint of moment of inertia, the head length H1 in the toe-heel direction is preferably greater than or equal to 110 mm, more preferably greater than or equal to 111 mm, and still more preferably greater than or equal to 112 mm. From the viewpoint of rules of golf regulating a head volume, the head length H1 is preferably less than or equal to 129 mm, more preferably less than or equal to 128 mm, and still more preferably less than or equal to 127 mm.

With a view to improving the ball catchability by utilizing air resistance, and from the viewpoint of moment of inertia, the head volume is preferably greater than or equal to 400 cm^3, more preferably greater than or equal to 410 cm^3, still more preferably greater than or equal to 420 cm^3, further more preferably greater than or equal to 430 cm^3, even more preferably greater than or equal to 440 cm^3, and still even more preferably greater than or equal to 450 cm^3. From the viewpoint of the rules of golf, the head volume is preferably less than or equal to 470 cm^3, more preferably less than or equal to 465 cm^3, and still more preferably less than or equal to 460 cm^3.

A double-pointed arrow FP in FIG. **18** shows face progression. The face progression FP is a length from the shaft axis line Z to the frontmost point (face-most point) of the head. The face progression FP is measured in the face-back direction.

An excessively small face progression FP causes golfers to feel a sense of incongruity in the shape of the head. From this viewpoint, the face progression FP is preferably greater than or equal to 13 mm, more preferably greater than or equal to 14 mm, and still more preferably greater than or equal to 15 mm. An excessively large face progression FP also causes golfers to feel a sense of incongruity in the shape of the head. From this viewpoint, the face progression FP is preferably less than or equal to 23 mm, more preferably less than or equal to 22 mm, and still more preferably less than or equal to 21 mm.

FIG. **28** is a plan view of a head **304** according to Reference Example. FIG. **29** is a perspective view of the head **304**, with its sole **314** faced upward, as viewed from the heel back side. FIG. **30**A shows the head **304** in the 0-degree state. FIG. **31**A shows the head **304** in the 15-degree state. FIG. **32**A shows the head **304** in the 90-degree state. In FIG. **30**A, FIG. **31**A, and FIG. **32**A, the projection direction PD**1** is a direction perpendicular to the drawing sheets of these figures.

FIG. **30**B is a projection figure of the head **304** in the 0-degree state divided by the shaft axis line Z into two regions. FIG. **31**B is a projection figure of the head **304** in the 15-degree state divided by the shaft axis line Z into two regions. FIG. **32**B is a projection figure of the head **304** in the 90-degree state divided by the shaft axis line Z into two regions.

The head **304** includes a face portion **310**, a crown portion **312**, a sole portion **314**, and a hosel portion **316**. The face portion **310** includes a striking face **310***a*. The striking face **310***a* is the outer surface of the face portion **310**. The crown portion **312** forms a crown outer surface **312***a*. The sole portion **314** forms a sole outer surface **314***a*. The hosel portion **316** has a shaft hole **316***a*.

The head **304** includes no protruding portion on its outer surface. There is no additional area added by the presence of a protruding portion in any projection figure of the head **304**. Ab**90** (FIG. **32**B) includes no additional area added by the presence of a protruding portion. Ab**15** (FIG. **31**B) includes no additional area added by the presence of a protruding portion. Ab**0** (FIG. **30**B) includes no additional area added by the presence of a protruding portion.

When the head **304** is made shallower, Af**15** and Af**0** decrease, and Ab**90** also decreases. At an initial stage of face rotation, accordingly, a force acting in such a direction that the face **10***a* is closed can decrease. A shallow head means a head having a small dimension in the up-down direction.

When the head **304** is made deeper, Ab**90** increases, and Af**15** and Af**0** also decrease. A force acting in such a direction that the face **10***a* is opened, accordingly, can increase at and/or near impact. In addition, air resistance acting on the entirety of the head **304** increase at and/or near impact, whereby the head speed can decrease. A deep head means a head having a large dimension in the up-down direction.

EXAMPLES

Hereinafter, advantageous effects of the present disclosure are clarified by examples, but the present disclosure should not be exclusively interpreted based on the descriptions of the examples.

Examples 1 to 3

A head having the same shape as that of the head **4** of the first embodiment was produced as Example 1. A head having the same shape as that of the head **104** of the second embodiment was produced as Example 2. A head having the same shape as that of the head **204** of the third embodiment was produced as Example 3.

Comparative Examples 1 to 5

As Comparative Example 1, a driver head sold as "XXIO 10 PRIME" manufactured by Sumitomo Rubber Industries, Ltd. was used. As Comparative Example 2, a driver head (loft angle: 10.5°) sold as "SRIXON Z725" manufactured by Sumitomo Rubber Industries, Ltd. was used. As Comparative Example 3, a driver head (loft angle: 10.5°) sold as "SRIXON ZR-30" manufactured by Sumitomo Rubber Industries, Ltd. was used. As Comparative Example 4, a driver head (loft angle: 10.5°) sold as "SRIXON ZR-700" manufactured by Sumitomo Rubber Industries, Ltd. was used. As Comparative Example 5, a driver head (loft angle: 10.5°) sold as "XXIO 11" manufactured by Sumitomo Rubber Industries, Ltd. was used. As with the above-described Reference Example, each of Comparative Examples 1 to 5 does not include any protruding portion in the crown portion or the sole portion.

Comparative Example 6

FIG. **33** is a plan view of a head **404** of Comparative Example 6 as viewed from the crown side. FIG. **34**A is a projection figure of the head **404** in the 0-degree state. FIG. **34**B shows a projected area of the head **404** in the 0-degree state divided by the shaft axis line into a first region and a second region. FIG. **35**A is a projection figure of the head **404** in the 15-degree state. FIG. **35**B shows a projected area of the head **404** in the 15-degree state divided by the shaft axis line into a first region and a second region. FIG. **36**A is a projection figure of the head **404** in the 90-degree state.

FIG. **36**B shows a projected area of the head **404** in the 90-degree state divided by the shaft axis line into a first region and a second region. The head **404** includes a face portion **410**, a crown portion **412**, a sole portion **414**, and a hosel portion **416**. The face portion **410** includes a striking face **410***a*. The crown portion **412** forms a crown outer surface **412***a*. The sole portion **414** forms a sole outer surface **414***a*. The hosel portion **416** has a shaft hole **416***a*. The head **404** includes a protruding portion at a substantially center position of the sole outer surface **414***a*. Golf clubs each having the head of Comparative Example 6 are now widely available on the market.

Respective specifications and evaluation results of Examples are shown in Table 1 below. Respective specifications and evaluation results of Comparative Examples are shown in Table 2 below.

TABLE 1

Specifications and Evaluation Results of Examples

	Unit	Ex. 1	Ex. 2	Ex. 3
WA90	mm^2	6881	6910	6768
Af90	mm^2	1160	1160	1160
Ab90	mm^2	5721	5750	5608
S90	mm^2	−4561	−4590	−4448
WA90/Ab90	mm^2	1.203	1.202	1.207
WA30	mm^2	6960	7017	6960
Af30	mm^2	4967	5000	4967
Ab30	mm^2	1993	2017	1993
S30	mm^2	2974	2983	2974
WA30/Ab30	mm^2	3.49	3.48	3.49
WA15	mm^2	6547	6546	6562
Af15	mm^2	5503	5502	5502
Ab15	mm^2	1044	1044	1060
S15	mm^2	4459	4458	4442
WA15/Ab15	mm^2	6.269	6.271	6.193
WA0	mm^2	6058	6062	6193
Af0	mm^2	5571	5575	5571
Ab0	mm^2	487	487	622
S0	mm^2	5084	5088	4949
|S90|/|S15|	—	1.02	1.03	1.00
(S15-S0)/15	mm^2/deg	−42	−42	−34
Value of θ at which Sθ is zero	degree	52.1	51.7	52.6
Value of θ at which WAθ/Abθ is 2.0	degree	52.1	51.7	52.6
Head length H1	mm	125.0	125.0	127.0
Head width W1	mm	123.0	123.0	123.0
Head volume	cm^3	450	448	449
Face progression FP	mm	17.5	17.5	17.5

TABLE 2

Specifications and Evaluation Results of Comparative Examples

	Unit	Comp. Ex. 1 PRIME 10	Comp. Ex. 2 Z725	Comp. Ex. 3 ZR-30	Comp. Ex. 4 ZR-700	Comp. Ex. 5 XXIO 11	Comp. Ex. 6
WA90	mm^2	6666	6827	6835	7225	6784	7546
Af90	mm^2	1220	1270	1302	1384	1267	1388
Ab90	mm^2	5446	5557	5533	5841	5517	6159
S90	mm^2	−4226	−4287	−4231	−4456	−4250	−4771
WA90/Ab90	mm^2	1.224	1.229	1.235	1.237	1.230	1.225
WA30	mm^2	7010	6686	6690	7089	6869	6827
Af30	mm^2	4982	4907	5069	5365	5000	5408
Ab30	mm^2	2028	1778	1621	1724	1868	1419
S30	mm^2	2954	3129	3449	3641	3132	3990
WA30/Ab30	mm^2	3.46	3.76	4.13	4.11	3.68	4.81
WA15	mm^2	6562	6354	6483	6780	6487	6638
Af15	mm^2	5514	5440	5550	5869	5490	5902
Ab15	mm^2	1048	914	933	911	997	736
S15	mm^2	4466	4526	4618	4958	4494	5166
WA15/Ab15	mm^2	6.263	6.951	6.951	7.444	6.509	9.020
WA0	mm^2	6085	6263	6510	6677	6137	6848
Af0	mm^2	5593	5684	5858	6060	5645	6287
Ab0	mm^2	492	579	652	617	492	560
S0	mm^2	5101	5104	5205	5443	5153	5727
|S90|/|S15|	—	0.95	0.95	0.92	0.90	0.95	0.92
(S15-S0)/15	mm^2/deg	−42	−39	−39	−32	−44	−37
Value of θ at which Sθ is zero	degree	53.2	54.9	57.5	57.2	55.4	58.3
Value of θ at which WAθ/Abθ is 2.0	degree	53.2	54.9	57.5	57.2	55.4	58.3
Head length H1	mm	123.9	114.6	117.3	118.8	124.8	124.9
Head width W1	mm	114.7	108.0	103.5	106.3	115.1	121.0
Head volume	cm^3	449	418	425	460	456	460
Face progression FP	mm	18.9	18.0	18.0	18.5	19.0	17.1

As these evaluation results indicate, the superiority of the present disclosure is obvious.

[Clause 1]

A golf club head including:

a face portion that forms a striking face;

a crown portion that forms a crown outer surface;

a sole portion that forms a sole outer surface; and

a hosel portion that is configured to receive a shaft and that defines a shaft axis line, wherein

the striking face has a face center, and a normal line at the face center,

the golf club head has a head width in a face-back direction of greater than or equal to 100 mm,

the golf club head has a head length in a toe-heel direction of greater than or equal to 110 mm,

a state of the golf club head placed in such a manner that the shaft axis line is vertical to a horizontal plane and the normal line is parallel to a first perpendicular plane on which the shaft axis line lies is defined as a 0-degree state,

a direction that is parallel to the first perpendicular plane and is parallel to the horizontal plane is defined as a projection direction,

a projected area of the golf club head projected in the projection direction when the golf club head is rotated by θ° about the shaft axis line toward a back side from the 0-degree state is denoted by WAθ (mm^2), θ ranging from 0 to 90,

the projected area is divided by the shaft axis line into two regions,

of the two regions, a region to which a force acting in such a direction that the striking face is opened is applied due to air resistance during downswing is defined as a first region, and a region to which a force acting in such a direction that the striking face is closed is applied due to the air resistance is defined as a second region,

an area of the first region is denoted by Afθ (mm^2),

an area of the second region is denoted by Abθ (mm^2),

a difference (Afθ−Abθ) is denoted by Sθ (mm^2),

S90 is less than or equal to −4500 (mm^2), and

S**15** is less than or equal to 4700 (mm^2).

[Clause 2]

A golf club head including:

a face portion that forms a striking face;

a crown portion that forms a crown outer surface;

a sole portion that forms a sole outer surface; and

a hosel portion that is configured to receive a shaft and that defines a shaft axis line, wherein

the striking face has a face center, and a normal line at the face center,

the golf club head has a head width in a face-back direction of greater than or equal to 100 mm,

the golf club head has a head length in a toe-heel direction of greater than or equal to 110 mm,

a state of the golf club head placed in such a manner that the shaft axis line is vertical to a horizontal plane and the normal line is parallel to a first perpendicular plane on which the shaft axis line lies is defined as a 0-degree state,

a direction that is parallel to the first perpendicular plane and is parallel to the horizontal plane is defined as a projection direction,

a projected area of the golf club head projected in the projection direction when the golf club head is rotated by θ° about the shaft axis line toward a back side from the 0-degree state is denoted by WAθ (mm^2), θ ranging from 0 to 90,

the projected area is divided by the shaft axis line into two regions,

of the two regions, a region to which a force acting in such a direction that the striking face is opened is applied due to air resistance during downswing is defined as a first region, and a region to which a force acting in such a direction that the striking face is closed is applied due to the air resistance is defined as a second region,

an area of the first region is denoted by Afθ (mm^2),

an area of the second region is denoted by Abθ (mm^2),

a difference (Afθ−Abθ) is denoted by Sθ (mm^2),

a ratio (WA**90**/Ab**90**) is less than or equal to 1.205, and

a ratio (WA**15**/Ab**15**) is less than or equal to 7.00.

[Clause 3]

A golf club head including:

a face portion that forms a striking face;

a crown portion that forms a crown outer surface;

a sole portion that forms a sole outer surface; and

a hosel portion that is configured to receive a shaft and that defines a shaft axis line, wherein

the striking face has a face center, and a normal line at the face center,

the golf club head has a head width in a face-back direction of greater than or equal to 100 mm,

the golf club head has a head length in a toe-heel direction of greater than or equal to 110 mm,

a state of the golf club head placed in such a manner that the shaft axis line is vertical to a horizontal plane and the normal line is parallel to a first perpendicular plane on which the shaft axis line lies is defined as a 0-degree state,

a direction that is parallel to the first perpendicular plane and is parallel to the horizontal plane is defined as a projection direction,

a projected area of the golf club head projected in the projection direction when the golf club head is rotated by θ° about the shaft axis line toward a back side from the 0-degree state is denoted by WAθ (mm^2), θ ranging from 0 to 90,

the projected area is divided by the shaft axis line into two regions,

of the two regions, a region to which a force acting in such a direction that the striking face is opened is applied due to air resistance during downswing is defined as a first region, and a region to which a force acting in such a direction that the striking face is closed is applied due to the air resistance is defined as a second region,

an area of the first region is denoted by Afθ (mm^2),

an area of the second region is denoted by Abθ (mm^2),

a difference (Afθ-Abθ) is denoted by Sθ (mm^2), and

a ratio (|S**90**|/|S**15**|) is greater than or equal to 1.00,

where |S**90**| means an absolute value of S**90**, and |S**15**| means an absolute value of S**15**.

[Clause 4]

The golf club head according to any one of clauses 1 to 3, wherein a value of θ at which Sθ is zero is less than or equal to 55°.

[Clause 5]

The golf club head according to any one of clauses 1 to 4, wherein a value of θ at which a ratio (WAθ/Abθ) is 2.0 is less than or equal to 55°.

[Clause 6]

The golf club head according to any one of clauses 1 to 5, wherein (S**15**−S**0**)/15 is greater than −35 (mm^2/deg).

[Clause 7]

The golf club head according to any one of clauses 1 to 6, having a head volume of greater than or equal to 400 cm^3.

[Clause 8]

The golf club head according to any one of clauses 1 to 7, having a face progression of greater than or equal to 13 mm and less than or equal to 23 mm.

[Clause 9]

The golf club head according to any one of clauses 1 to 8, further including a protruding portion on an outer surface of the golf club head, wherein

the protruding portion increases Ab**90**, and does not increase Af**15**.

[Clause 10]

The golf club head according to clause 9, wherein the protruding portion is provided on the crown outer surface.

LIST OF REFERENCE SYMBOLS

2 Golf club
4, **104**, **204**, **304** Head
6 Shaft
10, **110**, **210**, **310** Face portion
10*a*, **110***a*, **210***a*, **310***a* Striking face (Face)
12, **112**, **212**, **312** Crown portion
12*a*, **112***a*, **212***a*, **312***a* Crown outer surface
14, **114**, **214**, **314** Sole portion
14*a*, **114***a*, **214***a*, **314***a* Sole outer surface
16, **116**, **216**, **316** Hosel portion
20, **120**, **220** Protruding portion
Z Shaft axis line
PD**1** Projection direction

The above descriptions are merely illustrative and various modifications can be made without departing from the principles of the present disclosure.

The terminology used in the description of the various described embodiments herein is for the purpose of describing particular embodiments only and is not intended to be limiting. The use of the terms "a", "an", "the", and similar referents in the context of throughout this disclosure (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. As used throughout this disclosure, the word "may" is used in a permissive sense (i.e., meaning "having the potential to"), rather than the mandatory sense (i.e., meaning "must"). Similarly, as used throughout this disclosure, the terms "comprising", "having", "including", and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted.

What is claimed is:

1. A right-handed golf club head comprising:

a face portion that forms a striking face;

a crown portion that forms a crown outer surface;

a sole portion that forms a sole outer surface;

a hosel portion that is configured to receive a shaft and that defines a shaft axis line, and

a protruding portion disposed on an outer surface of the golf club head, wherein

the striking face has a face center, and a normal line at the face center,

the golf club head has a head width in a face-back direction of greater than or equal to 100 mm,

the golf club head has a head length in a toe-heel direction of greater than or equal to 110 mm,

a state of the golf club head placed in such a manner that the shaft axis line is vertical to a horizontal plane and the normal line is parallel to a first perpendicular plane on which the shaft axis line lies is defined as a 0-degree state,

a direction that is parallel to the first perpendicular plane and is parallel to the horizontal plane is defined as a projection direction,

a projected area of the golf club head projected in the projection direction when the golf club head is rotated by θ° about the shaft axis line toward a back side from the 0-degree state is denoted by WAθ (mm^2), θ ranging from 0 to 90,

the projected area is divided by the shaft axis line into two regions,

of the two regions, a left-side region is defined as a first region, and a right-side region is defined as a second region,

an area of the first region is denoted by Afθ (mm^2),

an area of the second region is denoted by Abθ (mm^2),

a difference (Afθ−Abθ) is denoted by Sθ (mm^2),

S90 is less than or equal to −4500 (mm^2),

S15 is less than or equal to 4700 (mm^2), and

the protruding portion increases Ab**90** and does not increase Af**15**.

2. A golf club head comprising:

a face portion that forms a striking face;

a crown portion that forms a crown outer surface;

a sole portion that forms a sole outer surface;

a hosel portion that is configured to receive a shaft and that defines a shaft axis line, and

a protruding portion disposed on an outer surface of the golf club head,

wherein

the striking face has a face center, and a normal line at the face center,

the golf club head has a head width in a face-back direction of greater than or equal to 100 mm,

the golf club head has a head length in a toe-heel direction of greater than or equal to 110 mm,

a state of the golf club head placed in such a manner that the shaft axis line is vertical to a horizontal plane and the normal line is parallel to a first perpendicular plane on which the shaft axis line lies is defined as a 0-degree state,

a direction that is parallel to the first perpendicular plane and is parallel to the horizontal plane is defined as a projection direction,

a projected area of the golf club head projected in the projection direction when the golf club head is rotated by θ° about the shaft axis line toward a back side from the 0-degree state is denoted by WAθ (mm^2), θ ranging from 0 to 90,

the projected area is divided by the shaft axis line into two regions,

of the two regions, a region to which a force acting in such a direction that the striking face is opened is applied due to air resistance during downswing is defined as a first region, and a region to which a force acting in such a direction that the striking face is closed is applied due to the air resistance is defined as a second region,

an area of the first region is denoted by Afθ (mm^2),

an area of the second region is denoted by Abθ (mm^2),

a difference (Afθ−Abθ) is denoted by Sθ (mm^2),

a ratio ((|**S90**|/|**S15**|) is greater than or equal to 1.00,

where |**S90**| means an absolute value of **S90**, and |**S15**| means an absolute value of **S15**, and

the protruding portion increases Ab**90** and does not increase Af**15**.

3. The golf club head according to claim **1**, wherein a value of θ at which Sθ is zero is less than or equal to 55°.

4. The golf club head according to claim **1**, wherein a value of θ at which a ratio (WAθ/Abθ) is 2.0 is less than or equal to 55°.

5. The golf club head according to claim **1**, wherein (S**15**–S**0**)/15 is greater than −35 (mm^2/deg).

6. The golf club head according to claim **1**, having a head volume of greater than or equal to 400 cm^3.

7. The golf club head according to claim **1**, having a face progression of greater than or equal to 13 mm and less than or equal to 23 mm, wherein

the face progression is a length from the shaft axis line to a frontmost point of the golf club head and is measured in the face-back direction.

8. The golf club head according to claim **1**, wherein the protruding portion is provided on the crown outer surface.

9. The golf club head according to claim **2**, wherein a value of θ at which Sθ is zero is less than or equal to 55°.

10. The golf club head according to claim **2**, wherein a value of θ at which a ratio (WAθ/Abθ) is 2.0 is less than or equal to 55°.

11. The golf club head according to claim **2**, wherein (S**15**–S**0**)/15 is greater than −35 (mm^2/deg).

12. The golf club head according to claim **2**, wherein the protruding portion is provided on the crown outer surface.

* * * * *